THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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LEGISLATION FOR CABLE PROPERTY.

THERE has been much correspondence lately in the leading newspapers respecting submarine cables and the laws necessary for their efficient protection.

The value of the cables now existing is so immense, intrinsically, imperially, and commercially, that probably no one who knows anything of the subject will be found to deny the desirability of International legislation, both to keep as far as possible those cables in repair, or when broken, to facilitate their restoration rapidly to their usual working condition.

After carefully considering the various questions which present themselves for examination in connection with this subject, we would suggest that the attainment of the above objects might be greatly assisted if laws were passed to enforce, in the first instance, a respect for the rights of "first comers" to a cable ground, and in the second, by obtaining for cable ships a freedom from those Custom House formalities at present obtaining in many countries.

The question of the protection of cables is a very wide one, and includes not only protection from the damage that may arise from anchors and fishing operations, but also from the injury which may ensue from laying cables too closely together.

Pre-supposing that legislation had been effected, then if in relation to our first suggestion we consider the subject of damage from anchors, the matter would simply resolve itself into the legal question—*was the cable laid over a generally accepted anchorage, or did the ship anchor on what was legally defined as cable ground?*

In the case of fishing operations, the question for consideration would be "*was the cable laid over a well-recognised fishing ground, or was the fishing carried on over cable ground?*" Admit now for the sake of argument, these methods of regarding the questions, and then let us suppose that it is necessary to lay a cable through a recognised fishing ground; it is evident that by so doing, the laying of the cable must depreciate the value of this resort of fishermen, and it would consequently be but fair and just that an indemnity should be paid to the association representing these fishermen, who, in this case, must be considered the "first comers." This indemnity would purchase for the cable a right in that ground, and it would consequently be perfectly justifiable afterwards to recover the total amount of any damage done to such cables by the fishermen, from the fishing association which granted the said indemnity. Of course, in the reverse case, a similar law might be made to apply in an equally just manner, as for instance, if fishermen were to encroach on what, by virtue of being first comers, might be termed cable ground; then it should be legally possible to obtain redress from them, through their association, for trespass and consequent damage to the cable property. An almost parallel arrangement could also be applied to the right of existing cables over those of any lines which it might be desired afterwards to lay.

Cable ground might, perhaps, with advantage be defined as one mile on either side of the cable at the beach, and seaward for the distance of ten miles, and two or three miles on either side beyond that distance from the shore. It would also be desirable to rule that no fishermen should be permitted to fish closer to the lines than the distances given above, without a special license from the company owning the cable, and that no ship should be allowed to anchor inside those distances without a similar license, also that no new line should be laid closer than the aforesaid distances.

Should however it be absolutely necessary for new cables to be laid closer than these limits, or even to cross a pre-existing line, we would in such cases suggest that a fair indemnity should be paid to the said first comer for this encroachment on its rights, and consequent depreciation of its property.

In considering our second suggestion, it will be well, perhaps, to point out the difficulties which it is desired to remove thereby, and to cite a few of the experiences of those who have had to face, and eventually overcome, them; and afterwards to give as briefly as we can the method in which we think those difficulties may with future legislation be avoided.

The India Rubber Company's ship in repairing one of the Direct Spanish Telegraph Company's cables put into Santander, and before *pratique* could be obtained, enabling her to go on with her work in the port, lists of all the steward's and other stores on board had to be drawn up and handed to the Custom House officials. On this particular occasion the cargo on board was stated as a small quantity of submarine cable and ballast. Owing however to the ship occasionally anchoring in Santander Harbour, sometimes in Bilbao Bay, and at others for the sake of shelter under Cape Machichaco, she was not in strict accordance with the Custom House laws of Spain, and before she was able to clear for the return voyage to London, the Spanish Administrator insisted upon

Mr. Saint Martin, the company's agent, giving a bond that the statement as to what was on the ship was correct. Mr. Saint Martin wrote to his company for a certificate that the cable and ballast which the ship had on board at Santander did in reality arrive in London, saying that this certificate was necessary to free his bond. In the end, we believe, the company had to get Senor Aparicio to ask the Minister in Madrid to give special instructions in the matter to the Chief of the Customs in Santander, which he eventually did. The enormous trouble involved in this case is self-evident.

In the following year the India Rubber Company again had to send a ship there, but as there was sufficient time, between the break of the cable and her arrival on the ground, to obtain a special permission from the Minister in Madrid, the delay which otherwise might have ensued was avoided. Even in France when laying the Marseilles-Algiers cable, some trouble and considerable delay was experienced, because the Chief of the Customs in Marseilles was not quite satisfied with the general instructions sent to him from the Minister in Paris.

But perhaps one of the worst instances we can give occurred during the operations of the late Mexican cable expedition. Brazos Santiago is an open roadstead, near the mouth of the Rio Grande river, and being in Texas, consequently comes under the United States Customs laws. When the *Dacia* arrived off Brazos, it was necessary to land some testing instruments and the testing hut, the value of the instruments being about £120. When the instruments were landed they had to be passed through the Customs, where much formality had to be gone through, and tonnage dues to the amount of £118 paid. This sum is a charge made irrespective of the value or quantity of material landed, and depends completely on the size of the ship. During the time these business arrangements were being carried out, bad weather set in, and as there is a heavy bar to cross, between the ship's anchorage and the landing stage, which bar is at times impassable for several days together, the ship was compelled to lie outside, waiting till it again became possible to communicate with the shore.

Many instances of a similar kind might be given, but the foregoing are sufficient for the purpose of illustration.

The remedy for this state of things, involving as it does annoyance and needless loss of time, is very simple, as all cable ships should undoubtedly be placed on the same footing as Government vessels, so far as custom formalities are concerned. The Brazilian Government, we believe, is the only one which has thoroughly recognised the difficulties which must arise if cable ships are placed on the same footing as vessels carrying ordinary merchandise. The *Norseman*, the repairing steamer of the Western and Brazilian Company, is allowed to go into or out of harbour without the usual Custom House routine, and in fact the existence of the ship is almost ignored by the Custom House Officials, the only rule observed being one more of etiquette than anything else, namely, that the senior naval officer in the port has an intimation given him that the ship has to proceed to sea for cable repairs, and that is a task which is easily accomplished whilst steam is being got up.

We may mention that the ss. *Retriever*, on the West Coast of America, finds very little difficulty with the Customs, as the Governments of Chili and Peru have always given a general order to the different Custom authorities in the ports of those countries to allow this vessel to go in and out and to carry on operations in the ports without any interference.

An International recognition of cable ships is very desirable in the interests alike of the public and of those connected with the repairing operations, as every day saved means a more speedy re-establishment of telegraphic communication.

The question of legislation is one which must eventually *force* itself on the attention of governments, and it is therefore desirable that steps should be taken in this direction at once. Every nation is interested in the maintenance of cable communication, and that almost in a certain, direct proportion, the factors determining that proportion for each country being its colonial extensions, its naval superiority, and its commercial relations.

Great Britain must of course stand amongst the nations most deeply interested, not only on account of her colonies, her naval stations, and her mercantile transactions, but also because her shores form a centre to which all the principal lines of telegraphic communication throughout the world converge. We venture to hope that the British Government will speedily take upon themselves the duty of initiating international legislation on the subject of cable property, in which all civilised (and we might almost say, all uncivilised) peoples are interested; in so doing they will adopt a course which must commend itself to the mind of every enlightened person throughout the universe.*

In reference to the above article it will be of interest to note the number and tonnage of the ships engaged in cable laying and repairing, as some idea of the importance of such operations may be gathered therefrom.

NAMES.	GROSS TONNAGE.
SS. Agnes	781
,, Ampère (French Government)	—
,, Calabria	3,325
,, Caroline	526
,, Charente (French Government)	—
,, Chiltern	1,304
,, Dacia	1,856
,, Duchess of Marlborough	402
,, Edinburgh	2,315
,, Faraday	4,908
,, Grappler	868
,, Great Northern	1,352
,, International	1,380
,, John Pender	1,213
,, Kangaroo	1,773
,, Minia	1,986
,, Norseman	1,372
,, H. C. Œrsted	570
,, Pouyer-Quertier	1,385
,, Professor Morse	1,023
,, Retriever	459
,, Retriever	624
,, Scotia	4,667
,, Seine	3,579
,, Sherard Osborne	1,429
,, Silvertown	4,935
,, Lady Carmichael	369
,, Patrick Stewart	1,130
	45,629

* We note, as we go to press, that it is proposed for the Telegraph Companies collectively to send a letter on the above subject to Lord Granville, and that this letter shall be followed up by a deputation, to be introduced by Mr. Pender, M.P.

THE EFFICIENCY OF ELECTRIC LAMPS.

A REPORT bearing the above title was made to our contemporary, the *Engineer*, during the Paris Electrical Exhibition, by Professors Ayrton and Perry. This paper is now reprinted in separate form, and will doubtless form a subject of the greatest interest to electric light engineers and all others directly or indirectly connected with this new enterprise. We have had long and exhaustive reports on the efficiency of the dynamo machine itself by such competent authorities as Mr. Schwendler, Dr. Hopkinson, Professors Houston and Thomson, and others; and this subject has been minutely dealt with from all points. But the credit of first considering the efficiency of the lamps themselves employed in the various systems of electric lighting must be awarded to Professors Ayrton and Perry, and we can only regret that the results given by these gentlemen in comparing the numerous lamps shown in their table

TABLE II.—*Experiments on some Electric Lights in the Paris Exhibition. All lights measured horizontally.*

Name.	Electromotive force in Volts between the two terminals of lamp.	Current in Amperes flowing through lamp.	Horse-power expended in the lamp.	Candle-power.		Candles per horse-power.		Mean candles per horse-power.
				Green.	Red.	Green.	Red.	
Crompton ...	37·7	25	1·26	2916	1849	2314	1467	1890
Joel, Semi-incandescent	6·6	44·2	0·39	70	60	179	154	166
,, ...	7·1	45·0	0·43	75	70	174	163	168
,, ...	6·6	50·0	0·44	75	68	170	155	162
Pilsen	36·8	10·33	0·48	780	512	1625	1066	1345
Brush	38	10	0·51	2025	961	3970	1884	2427
Sautier-Lemonnier. One lamp on A Gramme Machine ...	40	43	2·3	15376	3625	6685	2446	4565
Ditto	45	42	2·54	15376	9025	6054	3553	4803
Maxim Incandescent	53·6	3·32	0·24	135	120	562	500	531
Malkoff	45·3	8·3	0·50	307	307	794	614	704
Sautier-Lemonnier. One of ten lamps on H Gramme Machine ...	40	12·5	0·67	540	310	806	463	634
	,,	,,	,,	*784	125	1170	187	670
Gravier	46·6	9·2	0·58	1023	349	1273	604	1189
Serrin	31·1	35·8	1·49	2448	938	1616	630	1123
Cance	51·8	16·7	1·16	3445	1156	2970	997	1983
Weston	33·7	21·7	0·98	2663	1024	2717	1045	1881
Maxim Incandescent.	73	2·5	0·244	350	290	1434	1189	1311
	77	2·8	0·294	270	262	934	886	910
	77	2·8	0·294	350	350	1211	1211	1211
	81·3	2·8	0·305	422	350	1383	1148	1265
	85·3	3·3	0·377	512	360	1358	954	1156
Engine and dynamo machine running at higher and higher speeds	88	3·6	0·424	870		2050		
	105·5	4·6	0·650	1225		1883		
				†1370				

No. 2, which we print, and which is the only one we shall consider at present, should have been obtained under such difficulties, and that they were unable to take more than single tests on most of the lamps submitted to them; and we think that under the circumstances the report should not be looked upon as authoritative until it has been confirmed or modified by future tests of their own and those of other observers.

Some of the figures shown appear to be most contradictory, and we shall presently draw attention to those we think most important, and which we can only consider to be the results of errors in observation, which might easily occur from the hurried way in which the tests were made. Before doing this, however, it will be well to notice some other points in connection with this report. The idea of measuring the efficiency of the lamp itself without any reference to the machine producing the current, whether it (the machine) be good or bad, is of great value, and will set inventors of lamps considering whether they have given enough attention to the construction of their apparatus, so that all the current passing between the terminals of the lamp may be utilised in the arc itself, and not wasted in passing through extraneous resistance, whether such be due to wire coils in the circuit, bad contacts, bad and loosely fitting carbons, or any similar reasons. That some lamps are much better adapted for utilising the current passed through them than others is very evident, and we wish to call the attention of all electric light engineers to this important fact, which has certainly been overlooked up to the present, and which can now be studied by the method of testing the horse-power taken up by the lamp, and which any electrician can do for himself.

The new Dispersion Photometer devised by Messrs. Ayrton and Perry cannot well be criticised without giving details of the instrument, and it will be therefore wise to reserve judgment upon its efficiency until we have more particulars concerning it before us.

A plan of the instrument showing the internal arrangements would have been much more satisfactory than a perspective view of the outside. However, we may return to this on a future occasion and therefore we will not discuss now its merits or demerits, but content ourselves by reminding inventors of the different systems tested that whatever may be their opinions as to the comparative values of tests made by this photometer, and by the direct distance measurements, whether by illuminated screens or by comparing shadows, it was the only one used for the Paris results, and therefore each lamp is judged upon its merits, the form of photometer not entering into the question as long as all lamps are compared by the same instrument. Regarding the electrical apparatus used for measuring the current between the terminals of each lamp, the new ampère-meter seems to give correct results when tried in connection with a Siemens dynamometer, and we may therefore take it for granted that the quantity of current passing through each lamp is correctly stated. We think that in measuring the electromotive force of the current errors might have crept in. A dead beat galvanometer of 110 ohms resistance was used for this purpose, but not having enough resistance in itself for acting as a shunt to an electric lamp an additional resistance, varied in different experiments, was used.

* This measurement of light was made on Rumford's method.
† This lamp now broke.

This additional resistance might not have been correctly read off in some cases and thus the difference of potentials between the terminals might probably in particular instances be erroneous. That some such mistake occurred we feel sure; the deflections of the needles of both the ampère-meter and the dead beat galvanometer might not have always been accurately recorded, and probably to save time, instead of fixing the wires to the actual terminals of the lamps, they might have been merely placed against some portion of the lamp, and we need hardly remark how necessary it is in electric-lighting matters to secure good and clean connection.

Turning now to the before-mentioned table, No. 2, we will call attention first to the following statement regarding the performances of two well-known arc lamps, the "Brush" and the "Pilsen." Measurements between the terminals of these two lamps gave the following results :—Electromotive force in volts: Brush 38, Pilsen 37; current in ampères flowing through lamp: Brush 10, Pilsen 10·3; horse-power expended in lamp: Brush ·51, Pilsen ·48. It will be seen that for all practical purposes the electrical conditions of the two systems were identical, and of course the resistances between terminals must have been practically the same, and one would expect that the lights produced would also be equal; but we are told that observations through a green glass gave, Brush 2,025 candles, the Pilsen only 780; through a red glass, Brush 961 candles, the Pilsen 512; and that the candles per horse-power expended in the lamps = Brush, observed through green glass, 3,970 candles, through red glass, 1,884, the mean result being 2,427 candles; whilst the Pilsen lamp gave, when observations were taken through green glass, 1,625 candles, through red, 1,066, the mean result being 1,345 candles, or a little more than half that of Brush. Now this result, if true, could only occur through either an extraneous resistance in the Pilsen lamp absorbing a great part of the current passing through it or through an error of observation, and to this latter we must attribute the astonishing result, for it seems that the difference of observed candle-power in red glass and green, is, in the Brush system, as 1 : 2·10, whilst in the Pilsen, instead of getting the same proportion, we have the curious figures of 1 : 1·52. Is this due to errors in reading off the results or to any defect in the photometer? Both lamps have a solenoid of thick wire in the main circuit, and each has a shunt coil of nearly equal resistance, we believe. Brush uses carbons coated with a film of copper to lessen the resistance, which is not much in any case; whilst the Pilsen system has the ordinary carbon pencil.

We do not know whether the respective carbons employed vary in size, or if the measurement on the Brush lamp was made when the carbons were nearly consumed and that on the Pilsen when just started, but we believe that the readings for the Pilsen system were obtained early one evening, whilst the Brush system was not tested until after 11 o'clock, when everything was quiet and all other machines and lamps stopped. But in any case, the two lamps appear to be so alike in resistance that we should certainly have looked forward to seeing the same candle-power from each, and until we see the results of further tests it would be unfair to suppose the Pilsen lamp inferior to the Brush; for if the carbons of the former, during the hurried test it was submitted to, should have been burning in such a position that the greater part of the light was sent in an opposite direction to that in which the photometer was placed, it is obvious that a second test might have given entirely different and better results.

Take another instance—the Crompton system. We are not aware that this lamp has any considerable resistance independent of that in the arc itself to absorb any large part of the current passing, yet with the same electromotive force as the two before-mentioned lamp, and a current of 25 ampères flowing, 2½ times more quantity than either the Brush or Pilsen, and absorbing 1·26 horse-power in the lamp, we only get a candle-power per horse-power of 1890 or about ¾ that of Brush.

A still more astonishing result is shown in measuring the Sautier-Lemonnier lamp. The electromotive force is given as 40 volts (a trifle more than was shown in the Brush), the current in ampères 12·5, the above remark applying to this also, and the horse-power absorbed in the lamp ·67, yet this lamp only gives a mean result per horse-power of 634 candles. This was one of a circuit of 10. Another test of a similar lamp worked singly from a Gramme machine, and absorbing 2·3 horse-power with a current of electromotive force 40 volts and ampères 43, gives a mean measurement of 4,565 candles per horse-power, and another lamp tested in a similar way gave nearly the same figures.

These results are more like those we have been accustomed to see, for although somewhat high it must be remembered that Messrs. Ayrton and Perry particularly call attention to the fact that their photometer gives higher readings than those obtained by the ordinary methods of photometric measurement; but for all that, we observe that in several tables, to which we shall refer in a future article, their results in numerous experiments and those obtained by using Rumford's method agree very well and that in some instances the latter results are highest. But even here again we observe the same discrepancy existing in the observations through red and green glass which we pointed out in the case of the Brush and Pilsen. Both lamps give 15,376 candles seen through green glass, but one is stated to give through red glass 5,625 candles and the other 9,025. We might cite other instances of the great discrepancy existing in the observed candle-power of lamps which are in almost identical electrical conditions as to the current passing between their terminals, and we can only reiterate our statements that these varying results can only be due to either errors of observation in the various instruments employed during the tests or to an extraneous resistance in certain of the lamps absorbing a great part of the current; but as we do not see where or how this latter could be in the lamps named, we must reluctantly come to the conclusion that although such a series of tests would have been invaluable had there been sufficient time to take a number of observations on each system submitted, the present report from the Paris Exhibition is only of value in suggesting future measurements.

As far as casual observation goes, it was the opinion of many competent authorities that the Pilsen lamp held its own with all competitors in the Paris Exhibition, and that it gave as good a light at

any time as the Brush. Indeed, the Pilsen was the theme of general conversation when speaking on such matters, and was looked upon most favourably by all, and by many as the best arc light shown. But as we have before mentioned, a single test taken by an observer in a hurried manner and surrounded by the curious is not to be relied upon, and as those interested commercially in the economy and efficiency of the different methods may not be conversant with the numerous causes which may affect the measurements obtained, and will only look to the column in the Professors' table of results which give the candles produced per horse-power, we will say to such of the public or profession generally, that only exhaustive and numerous experiments by various competent observers should be seriously considered, and that the same conditions should obtain for each system tested.

Returning again to the photometer, we do not think that the difference of colour existing between the standard candle and the electric light is entirely eliminated by the method of observing through red or green glass, and we are also of opinion that different observers would get varying results with Professor Ayrton and Perry's apparatus, just as is always, or nearly always, the case in ordinary photometric observations.

The short distance employed between the end of their photometer and the source of light is in itself objectionable, for a slight error of measurement would tell for or against a lamp to a serious extent.

We feel sure that from the absence of any critical remarks by Messrs. Ayrton and Perry on the Paris tests, they are themselves dissatisfied with the figures obtained, which certainly cannot be reconciled with one another. It would be most interesting to hear from these gentlemen their opinion on the curious and contradictory results obtained with different lamps under the same electrical conditions, and which, if burning the same lengths and sizes of carbons should have given like results. Other columns might with advantage have been added to their table giving such items, and particularly a column for stating the number of lamps in each circuit when the tests were made.

The other portion of the report, which is independent of the Paris Exhibition, is of great value, the experiments being numerous and exhaustive in nearly every detail; the experiments with the Maxim lamp being especially full and interesting. It may surprise many that these lamps have given 1,000, 1,100, and 1,200 candle light per horse-power, but it is only a question of producing a carbon or other filament capable of bearing the necessary heat without breaking to raise its illuminating power to such a point. We shall hope to deal with this and the remaining portions of the report in our next issue, and we can only express our regret that as far as the Paris Exhibition tests are concerned, the results will be found more misleading than valuable, and we trust that Professors Ayrton and Perry may have future opportunities of making many observations on each of the lamps described by them, so that we may really have something definite to work upon, for up to the present there is a great vagueness in nearly all matters connected with electric lighting.

In conclusion, we will draw attention to the want of definition between the intensity and quantity of a light. We should have this defined as we have it in regard to electrical currents. A light may be of great intensity but of little volume, or the reverse.

THE PARIS ELECTRICAL EXHIBITION.

THE BRITISH SECTION.

REID'S FIRE ALARUM AND TELEPHONIC SIGNALLING APPARATUS.

IN this system, designed by Thomas Reid, jun., of Dundee, a loop of two wires is carried throughout a district, and led into a central station. Any number of signalling apparatus may be joined on to the loop without any additional battery power being required beyond what is necessary to work the signaller farthest away from the station.

In a convenient position outside the buildings is placed the alarum, fig. 1, from which the wire, 12, is led into all parts of the building; parallel to 12 is the wire, 24, which leads from the transmitter studs, 21, 24, to the earth. Communications between these wires can only take place by the heat acting on contacts kept apart by fusible plugs, or by contact being made by the action of heat on a compound metal strip. The time of contact may be regulated to any degree of heat.

In fig. 1, 22 and 23 indicate telephone studs; 21 and 24, transmitter studs; 25, a connection between a brass plate and an electro-magnet terminal; 16, a pin for a lifting contact weight, 17; on this contact weight are cut a number of notches, which make contact with the line wire spring, 15, when the weight drops, thus sending a combination of Morse signals for indicating the locality in which the instrument is placed; 13 is a contact spring connected to earth; 14 is a contact stud, also to earth. In the brass plate is a slot, 26, in which can slide the pin; 20 is a telephone; 27, a spring for pressing the lever 19 in contact with the insulated earth contact stud, 18, when the telephone is lifted off the lever; 28 is a spring which keeps the weight, 17, raised by means of the small projection, 29 (fig. 1A), hanging on to plate 30, and keeps contact with the plate when the weight falls; 31 and 32 are connections from electro-magnet terminals to the starting wire; 33 is a contact spring; and 34 a contact stud for completing the circuit of the line wire; 30 is an insulated plate screwed to the guides, 35 and 36.

In fig. 2, 1 and 1 are contact studs for the starting wire; and 2, 2, are contact studs for the belt at the alarum station; 4 is a spring for completing the circuit between the contact studs; 3 is a catch for keeping 4 out of contact with 1 and 1, when the current is passing along the line wire; 6 and 6 are line wire studs for the electro-magnet, 5; 7 is a battery; and 8, Morse instrument and telephone connections.

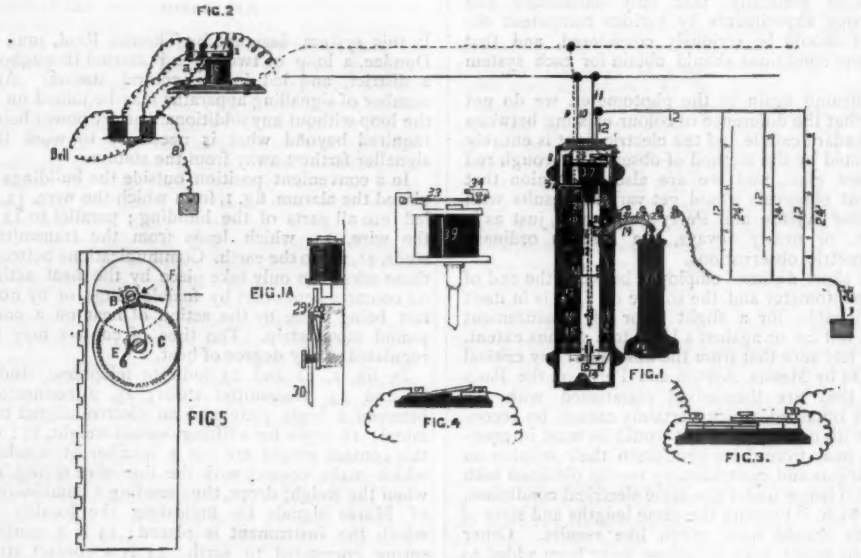
The current from the battery passes along the starting wire by means of the spring, 4, in contact with 1 and 1; it then passes down to contact spring, 31, 33, and 34, along to the successive instruments

in circuit. If contact should be made between 12 and 24, the current will pass through the electro-magnet by the terminal, 25, to the plate, 30, and to contact spring, 13, thence through 15 to the earth-wire, 12, 24. The electro-magnet, 37, will then break the circuit of all the instruments further away than itself by attracting the contact spring, 33; it also liberates the contact weight, 17, by pulling back the spring catch, 28 and 29. In falling the weight comes in contact with spring, 15, of line wire, the current passes through the electro-magnet, 5 (fig. 2), to line wire, and through 15, 13, 12, 24 to earth, throwing the starting wire out of circuit by breaking the contact of 4 with 1 and 1, throwing the bell in circuit by contact of 4 with lower contact studs, 2, 2, the catch, 3, keeping 4 in contact with 2, 2, until removed. The makes and breaks of the contact weight are recorded by a Morse recorder or other dot and dash signalling instrument, through which the current passes to the earth. In order to cause the weight to descend slowly, and thus make the signals lengthened and distinct, a train of wheels connected to a "fly" is contained in the weight; this train gears into a rack, down which the weight slides (fig. 5).

After the signal has been recorded, the attendant liberates the catch, 3, thus completing the circuit of the starting wire, which had been interrupted by the weight having lifted the contact spring, 13, out of contact with the earth stud, 14. Any other instrument can now signal, but no two instruments can signal at same time.

The telephone signal acts thus:—The person wishing to communicate with the station lifts the telephone from the lever, 19, the spring, 27, moves the lever, 19, into contact with the stud, 18, just above it, completing the circuit of the starting wire through the electro-magnet, 37, through plate, 30, along the lever, 19, and through the contact stud 18, and also through 21 and 24, to the earth wire, 24. The weight, 17, then falls into contact with the contact spring, 15, of the line wire, but cannot go further owing to the end of the lever, 19, passing across the slot. The current then passes along the line wire to 5 (fig. 2), breaks the circuit of the starting wire, and rings the bell, also making one dash in the Morse recorder. The attendant then throws his telephone and transmitter into circuit in the place of the Morse recorder.

When the telephone, 20, is replaced, the lever is moved out of contact with the earth connection, and the weight, 17, is lifted by means of the pin, 16, the latter having been resting on it. The apparatus is now in position for further signalling.



FOREIGN SECTIONS.

GOLFARELLI.

(*Italy.*)

The exhibits of MM. Golfarelli are as follows:—

Water Level Indicator.—This apparatus is of simple

construction, and both indicates and registers the rise and fall of the water in a reservoir.

Stenographic Apparatus.—This instrument is practically a pen, which records, by means of a combination of signs (instead of letters), any communication which is required to be written. There are two keys to the apparatus, by the depression of one or other, or both, of which, marks are recorded, which represent letters.

Dynamo-Electric Machine.—This machine differs from that of Paccinotti or Gramme in that the ring armature is induced both from the inside as well as the outside, so that nearly the whole of the wire on the ring is utilised for producing a current. The

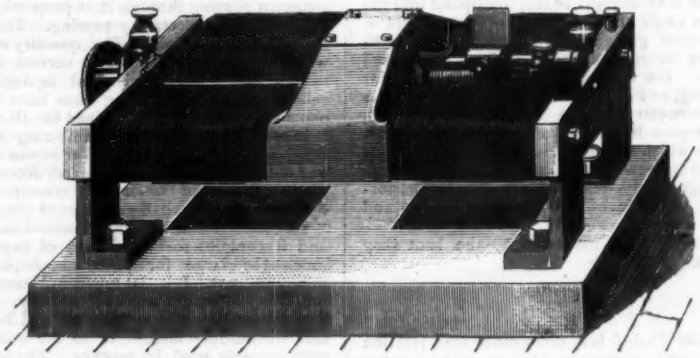


FIG. 1.

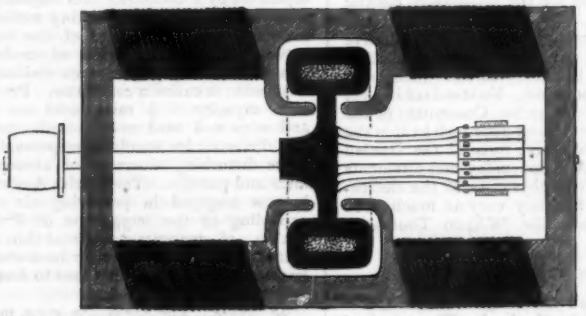


FIG. 2.

specimen of the machine which is shown at the Exhibition is very solidly constructed. Fig. 1 is a general view of the apparatus; fig. 2 is a section, showing the principle of the invention, which is self-evident.

Small Electric Lamp.—The principle of this lamp is identical with that of Wilde, but the mechanism which keeps the carbons apart is somewhat different.

Besides the foregoing, MM. Golfarelli exhibit an *Electro-Magnetic Counter*, without gearing, and also an improved form of galvanometer, which is very sensitive in its action.

ON THE PRACTICAL MEASUREMENTS OF ELECTRICAL MAGNITUDES.

By W. H. PREECE, F.R.S., Electrician to the General Post Office, London.

(*Continued from page* 483.)

16. Having thus determined the unit of resistance, all the other units follow as a matter of course. The *Weber* is the name given to the practical unit of current. It contains 10^{-1} c.g.s. absolute units of current. No standard instrument has yet been constructed to measure currents in webers. That most generally employed and probably the best for the purpose, is the electro-dynamometer, for it has the advantage of being independent of magnetism, and, therefore, it can be fixed anywhere. The electro-dynamometer is based on the mutual force exerted between two currents. One coil of wire is freely suspended within another, and the current to be measured flows through each. In Siemens' form this force is opposed by a torsion spring, which brings an index back to zero. The intensity of the current is measured by the amount of torsion applied, indicated by a hand passing over a graduated circle. Professor Helmholtz has devised an electro-dynamometer, by which the current is actually weighed, that is,

its intensity is measured by the mass of matter required to counterpoise its force.

The tangent galvanometer of Pouillet is equally useful and very exact. When we know the horizontal component of the earth's magnetism for the position in which the observation is made and the dimensions of the galvanometer itself, we can calculate directly the strength of the current from the formula :—

$$C = \frac{K}{2\pi n} H \tan \theta$$

when K is the radius of the circle, n the number of turns, H the horizontal component, and θ the angle of deflection. The ordinary way is to determine the constant of the instrument by using a standard cell, whose internal resistance and electromotive force are known. We thus obtain a co-efficient which, multiplied into the tangent of the angle of deflection, gives the current in webers. Tangent galvanometers can be used with advantage only for small currents such as those used in telegraphy. For such currents as those used for electric lighting, or for the transmission of power, the electro-dynamometer is more practical and exact. M. Marcel Deprez has introduced a very useful galvanometer, in which a light induced magnet is maintained in the powerful magnetic field of a large horseshoe magnet. Its readings are directly proportional to the intensity of the current passing, and they give the current in webers.

Currents can also be measured by the heat they develop. The equation :—

$$H = \frac{C^2RT}{J}$$

which expresses Joules' law, determines this relation and gives the result in gramme-degrees, or the number of grammes of water which would be raised 1° C. in temperature. One weber would raise 2405 grammes of water 1° C. in one second. This is a very useful method to determine the average value of alternate currents such as those used for the Jablochkoff electric light.

17. The *Volt* is the practical unit of electromotive force, and it contains 10^8 c.g.s. units of electromotive force. This may be due to no allowance being made for changes of temperature. No standard has yet been constructed of this unit by the Committee of the British Association. The nearest approach to it is the Daniell cell, but the electromotive force of the Daniell cell varies very much. A great many measurements have been made by different physicists of the electromotive force of this cell, but they vary as much as 10 per cent. from each other. Sir William Thomson's measurement, viz. :—

$$E = 1{\cdot}079 \times 10^8 \text{ c.g.s. units}$$

is a very good mean of all these observations, and it is that which is accepted in England. The standard cell used by the British Post-office is of this form, and has proved to be of great practical utility.*

Latimer Clark's zinc-mercury cell, the mercury in Hg_2SO_4 and the zinc in $ZnSO_4$ is remarkably constant when freshly made, but it has not stood the test of practice. Its electromotive force is 1·457 volts at 15·5° C.

* This standard cell is peculiar in this respect, that while it is charged with the purest chemicals it has two idle cells, the one filled with a solution of sulphate of copper and the other with water, in the first of which the copper plate and porous pot are kept, and in the second of which the zinc plate is placed. The central cell, which is only used when wanted for observation, has sulphate of zinc in it. It is wonderful how month after month this cell maintains its constancy. For use the plates are removed from the idle cells into the active one.

† It is unfortunate that we have not yet established a standard equivalent to a volt. This is a desideratum that remains to be obtained, and one of the most important duties that could be discharged by the Congress.

18. The unit of quantity is but very little used for practical purposes. It is derived from Faraday's law, which is expressed by the formula :—

$$Q = Ct.$$

and which implies that unit quantity is conveyed by unit current in unit time. It has not yet received a name, and it does not enter into much consideration in electro-magnetic measurement, for it is practically contained in the weber.* In electro-chemical phenomena, however, it is of great consequence. The weight of an electrolytic body, decomposed in a given time by a current passing through it, is proportional exactly to the quantity of electricity passing. This is true, even to the atomic weight. The quantity of a substance, which is decomposed by unit current in unit time, is called the "electro-chemical equivalent" of that substance, and this having once been determined for one substance can be determined for all electrolytes, for it is proportional to their combining numbers. It is for water 0·00092, or one weber in one second, that is, one unit of quantity (one ampère) decomposes 0·00092 of a gramme of water into 0·000102 grammes of hydrogen, and ·000318 grammes of oxygen. †

19. The "farad" is the practical unit of capacity, and it contains 10^{-9} c.g.s. units of capacity. This is much too large for practical purposes, and one millionth part of it is taken. Hence one microfarad = 10^{-15} c.g.s. units of capacity. It would have been better if the term "farad" had been applied to this submultiple instead of to the unit itself, for the unit is never used in practice. The capacity of any conductor is measured by the quantity of electricity it will contain when charged to unit electromotive force. A Leyden jar is a type of every system capable of retaining a charge of electricity. It involves two conductors separated by a dielectric. Its capacity varies directly with the area of the conducting surfaces opposed and inversely as the thickness of the insulating medium between them. Two sheets of tin-foil separated by thin paraffined paper or mica shellaced or paraffined, form what is called a *condenser*. Practical condensers of a capacity of $\frac{1}{4}$ microfarad are made of tin-foil and mica and used as standards, but air is the only safe dielectric for standard purposes, for it is free from those disturbing elements of absorption that vitiate mica and paraffin. The British Association Committee is now engaged in preparing air condensers made according to the suggestion of Professor Fleeming Jenkin, of concentric tubes of thin brass. They are measured by reference to an insulated sphere which is known in an unlimited space to have a capacity that is measured by its radius.

20. *Work.* The *erg* is the c.g.s. unit of work. It is the work done by a dyne through a centimetre, but it is so small that it is magnified a million times for practical purposes and called a *megerg* = 10^6 ergs.

Since the work done by any current per second is

* In fact the name "Weber" was intended originally to have been applied to unit quantity, but custom—that powerful inventor of new terms—has transferred it to current, for which a name was more wanted, and to which it is betted suited—"webers per second" was too long to remain in every day use in this age of progress.

† Weber determined that one weber decomposes one gramme of water in 2 hours 57½ minutes. Dr. G. Johnstone Stoney (B. A. 1874), calculated from the supposed dimensions of molecules as determined by Loschmidt, Sir William Thomson and himself, that it required 10^{20} ampères to decompose each molecule of water, and he proposed this magnitude as a natural physical quantity that deserved to be taken as a new fundamental unit.

obtained in ergs by the product of the current into the electromotive force producing it, or :—

$$W = C E.$$

H. P. or the horse-power condensed is found by dividing C E by 746, or

$$\frac{C E}{746} = \text{H.P.}$$

The gramme degree $= 42 \times 10^6$ ergs $= 42$ megergs. The pound degree $= 1{\cdot}91 \times 10^{10}$ ergs $= 19100$ megergs.

This unit of work is of vast importance in all questions relating to the economy of the electric light.

21. *Conclusion.* The physician's examination of the body of his patient by observation of the tongue, the pulse, the skin, and the temperature, is but tentative compared with the accuracy with which the physicist can examine the electrical condition of his apparatus and his inert bodies. The mental eye of the electrician can scan "the deep unfathomed caves of ocean." His theoretical insight can probe the impenetrable, it can open to the light of day the invisible portions of his little world.

It is impossible to exaggerate the benefit that the dynamical system of exact measurement has introduced into electrical engineering. It has been its "eureka." It has made submarine telegraphy practically and commercially possible, for it enables the engineer to calculate with wonderful accuracy the position of the smallest flaw in the longest cable, and in the deepest and roughest sea to direct his ship with unerring precision to the locality of a break. It has led to the improvement of the quality of the wire used so as to insure increased speed and greater economy of working. It has determined the quality of the materials used for insulating purposes, and while it has maintained their efficiency it has led to great economy in construction.

In England no wire either overland, underground, or submarine is allowed to be accepted without careful inspection and measurement of its resistance and capacity. In the British Post-office every apparatus is carefully measured, and each one being specified, it is rejected if it fails to comply with the electrical as well as the mechanical requirements of the specification. The improvement in working effected thereby is immense. Failure of apparatus, which was the most common of faults in working, has become now the least common. The condition of the wires of the country from day to day is obtained, and accurate inspection is maintained by noting the variation of the currents received at the end of the circuits. Instruments of research have become fine tools and true gauges in the hands of the physicists. Rough qualitative measurements have become truly quantitative.

Its benefits have been equally great in the other practical applications of electricity to useful purposes, especially in electric lighting and in the transmission of power. Indeed, without its aid it would have been impossible to have obtained that proper relation between power expended and useful effect produced, which alone has rendered this magnificent application of one of the great forces of nature to the wants of mankind practicable and profitable.

[P.S.—The above paper was translated for me into French by my friend, M. Alfred Niaudet, and printed by the proprietors of the Paris *L'Electricien** for distribution among the members of the International Electrical Congress assembled in Paris to discuss, among many others, the all-important question of units, with a view of establishing a system of electrical measures for international adoption.

* It originally appeared in this excellent paper.

The propositions enumerated above were not all adopted, but at the sitting of September 22nd, the following resolutions were unanimously agreed to :—

1. For electrical measurements, the fundamental units, the centimetre (for length), the gramme (for mass), and the second (for time), are adopted.

2. The ohm and the volt (for practical measures of resistance and of electromotive force or potential) are to keep their existing definitions, 10^9 for the ohm, and 10^8 for the volt.

3. The ohm is to be represented by a column of mercury of a square millimetre section at the temperature of zero Centigrade.

4. An international commission is to be appointed to determine, for practical purposes, by fresh experiments, the length of a column of mercury of a square millimetre section which is to represent the ohm.

5. The current produced by a Volt through an Ohm is to be called an Ampère.

6. The quantity of electricity given by an Ampère in a second is to be called a Coulomb.

7. The capacity defined by the condition that a Coulomb charges it to the potential of a Volt is to be called a Farad.

The international system of electrical units (Paris, 1881) is therefore represented in the following table :—

Symbol.	Electrical Quantities.	Nomenclature.	C. G. S. Units.
R	Resistance	Ohm ...	10
E	Electromotive Force	Volt... ...	10
K	Capacity	Farad ...	10^{-9}
Q	Quantity	Coulomb	10^{-1}
I	Intensity of Current	Ampère ...	10^{-1}

The conclusion is most satisfactory to all concerned, and it is hoped that this system will be speedily and universally adopted. The honoured name of Weber was replaced by Ampère because it was already in use in Germany to indicate a different value, and it was feared that its retention would lead to inconvenience.—W. H. P., Nov. 30, 1881.]

Correspondence.

TELEGRAPHING WITHOUT CONDUCTING WIRES, ETC.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In the issues of the TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW, dated the 15th January, 1878, and 1st March, 1879, it is stated that Professor Loomis, the distinguished American astronomer, has succeeded in telegraphing a distance of about 20 miles from the peaks of the mountains of West Virginia with the aid of *aerial currents*, and *without any conducting wires between the two stations*. As this subject is exceedingly useful and interesting to all electricians in all parts of the world, would you very kindly favour us, through the medium of your highly scientific and widely-circulated journal, with the exact details of the Professor's experiments, and state if any further advancement on the subject has been attained since the publication in the journal, as above-mentioned. I take this opportunity of asking you if there has been any *new edition* of Latimer-Clark and Sabine's "Electrical Tables

and Formulæ," since the one published either in 1870 or 1871? The subject of electrical measurement is getting so elaborate and advancing with such rapid strides, that I believe the time has approached for a *new edition, complete up to date*, being put in the hands of all telegraph engineers, electricians, and operators, and we hope the subject will attract the attention of some of our able electricians and engineers.

Could you kindly let us know if any pamphlet or notes on lectures have been published by Professor Ayrton of his lectures to the students in the City and Guilds Institute?

Simla, Yours truly,
Nov. 6th, 1881. INDIAN TELEGRAPH.

[We believe that no detailed description of Professor Loomis' experiments has been published, nor, as far as we know, has the subject been pursued further. No second edition of Clark and Sabine's "Electrical Tables and Formulæ," has been published, and we are not aware that the authors have any intention of compiling one. The subject of electrical measurement has been exhaustively treated by Mr. H. R. Kempe in the second edition of his work on "Electrical Testing," published by Messrs. Spon. This latter work is undoubtedly the most complete book on the subject yet issued. No pamphlet has yet been published by Professor Ayrton of his lectures before the City and Guilds Institute.—EDIT. TEL. JOUR.]

LIGHTNING CONDUCTORS.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I wish to protect a square house which has nine chimneys, all of equal height, from lightning by means of two iron rods, 3 ft. above two of the *centre* chimneys, connected by a galvanised iron wire conductor with the iron water pipe which supplies the house.

Will you kindly tell me if this protection will be sufficient, and whether two chimneys at the angles of the house would not be better than central ones, which I prefer owing to their being almost hidden from view by the parapet which surrounds the building? "B."

[Two rods are hardly sufficient to completely protect a building of the kind you describe; every chimney, especially if it be in use, is a source of danger. It would be decidedly preferable to place the two rods at the angles of the house rather than in the middle, but in any case the points of the rods should project a foot or two above the chimneys. The best plan would be to have a rod to each chimney, all connected to the lead of the roof, and also to the iron water pipe, the rods in this case need not project more than a few inches above the chimneys. If your iron water pipe is of a large size, it would probably be sufficient to act as the main conductor to the ground, but it would be advisable to have also two independent main conductors, one at each end of the house, carried down to the ground, and there either connected to earth plates in the moist earth, or to the water mains. It is essential that the conductors be of stout iron, if of the latter metal; the best conductors are those of copper rope, ½-inch in diameter, such as are supplied by Messrs. R. S. Newall & Co.—ED. TEL. JOUR.]

Notes.

THE PARIS ELECTRICAL EXHIBITION.—M. Cochéry intends to spend the surplus of the Electrical Exhibition, which is said to exceed £16,000, in establishing a research laboratory for electricity.

THE ELECTRIC LIGHT AT THE CATTLE SHOW.—This exhibition was lit by the Brush system.

THE EDISON ELECTRIC LIGHT IN NEW YORK.—The Edison Electric Light Company has begun to lay the wires for the illumination of a district in New York, bounded by Spruce Street on the north and Nassau Street on the west, the whole, when completed, containing fourteen miles of conductors. These are laid insulated in pipes which are cemented into boxes in which there is an expansion joint for the conductors, consisting of a copper loop. The conductors are half round in section, 1 inch broad and ¼ inch thick, and are made of copper. The pipes and their contents are buried about two feet below the ground. The company (says *Chambers' Journal*) have already contracted to supply 1,100 consumers with 9,000 16-candle and 4,000 8-candle lights. Wires have been laid to 980 buildings, including one printing office which is to be supplied with 550 lights and one with 600 lights. The company charge according to the amount of electricity consumed as registered by a metre. The lamps (which last about eight months) are supplied free of charge. Besides electric lamps, the current is employed to drive 214 pumps raising water to upper storeys, 2,309 sewing machines, hoists, elevators, &c. About 1,433 horse-power is consumed in supplying the current.

THE ELECTRIC LIGHT AT BARNSLEY.—Barnsley was on the 2nd inst. lighted with the electric light for the first time. The corporation have differed with the gas company. The latter will not concede the reductions which the corporation think should be made, and the council are trying the electric light as an experiment. If it answers it will be adopted. The light now used is that of the Brush system. Several business establishments also introduced the light in their shops. There are eight public lights.

THE ELECTRIC LIGHT IN PARIS.—The Paris Municipal Commission has resolved to illuminate successively the Council Hall with five different electric lights, to determine the price of each, and make a choice amongst them. These five have been selected out of all the systems exhibited. The Swan and Brush systems are two of those selected for the competition.

PHOTOMETRIC STANDARDS.—The committee on photometric standards have presented their report to the Board of Trade. They find that the method of taking the average of three consecutive candle determinations to indicate the illuminating power of coal gas does not yield satisfactory results. Not only do sperm candles exhibit intrinsic differences which unfit them for use as a standard, but the method of using them permits of variations which introduce serious errors into this mode of testing the illuminating power of coal gas. After a series of experiments with various photometric standards submitted to them, the committee recommend the adoption of Mr. A. G. Vernon Harcourt's air-gas flame, in which the combustible gas is a definite mixture, prepared by the operator, of air and the vapour of light petroleum. The gas is burnt at a definite rate from a ½-in. orifice in a brass burner, and the height of the flame is adjusted to 2½ in. At the same time they recommend that in official documents the quality of light furnished by coal gas, as shown by Mr. Harcourt's lamp, should be expressed as heretofore in standard candles.—*Engineer.*

TELEGRAPHIC COMMUNICATION BETWEEN DOVER AND THE CONTINENT.—Since the recent heavy gale, all direct communication between Dover and the Continent by the Submarine Telegraph Company's Boulogne

and Calais cables has been interrupted, both cables having been broken. The Boulogne cable runs between Cape Grisnez and Abbotscliff, near Dover. It is a six-wire cable, and was first laid in 1859. In 1875 the portion running between the Varne and the Cape was renewed, owing to the frequent damage caused by the roughness of the ground between those places, but since then until the present breakdown the cable has given little or no trouble. The Calais cable runs between Sandgatte on the French coast, and the South Foreland, on the English coast. The tests at the South Foreland show that the Boulogne cable is disconnected about three miles and a quarter from the shore at Cape Grisnez, the Calais cable having been parted at between five and six miles off Sandgatte. Several of the land wires between Dover and the cable ends on the English coast were blown down by the force of the wind. The Company's repairing ship, the *Lady Carmichael*, shipped a large quantity of new cable, and proceeded to repair the damage, but on the 3rd inst. she returned to Dover Harbour, as owing to the heavy sea on the French coast the engineers were unable to find the cables, several grapnels being broken in dredging for them.

ELECTRIC RAILWAYS.—Eisenach is to have an electric railway from the station to the castle of the Wartburgh, if the royal permission can be obtained. Mr. Siemens, of Messrs. Siemens and Halske, Berlin, is in America, and has been in consultation with Messrs. Gould, Sage, and Field, regarding the adaptation of his electrical motor to the requirements of the New York Elevated Railways. Mr. Sage is reported as favourably impressed with Mr. Siemens' representations, and intimates that experiments with the electric motor may be undertaken.

EDINBURGH STREET TRAMWAYS COMPANY AND ELECTRO-MOTORS.—The shareholders of the Edinburgh Street Tramways Company at a special meeting held at Edinburgh, have decided to apply to Parliament for powers to use mechanical and electric motors on their tramway system.

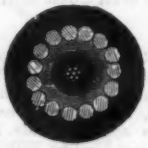
THE FAURE BATTERY.—We understand that the success of the Faure storage battery has not turned out to be so great as was anticipated; it is found that the felt wears into holes and that metallic lead forms between the plates causing short circuits, and of course entirely destroying the efficiency of the cells.

STORAGE BATTERIES.—Mr. Edison is making experiments on batteries for the storage of electric energy.

THE GRAMME PATENTS.—The *Paris Bourse* states that the Gramme patents for the transmission of motive power by electricity have become the property of a company constituted with a capital of £400,000, under the auspices of the Société Internationale des Téléphones.

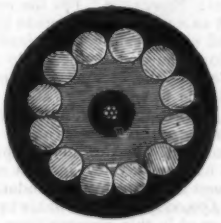
HONOURS TO A TELEGRAPH ENGINEER.—The *Telegrafista* of Rome for November announces that Mr. Alfred Egginton, representative in Italy of the Eastern Telegraph Company, has been nominated by his Majesty King Humbert, Chevalier of the order of the Crown of Italy.

CENTRAL AND SOUTH AMERICAN TELEGRAPH COMPANY'S CABLES.—As implied in our last issue, we give a brief outline and sketches of the various types of cable now being manufactured at Silvertown for the above company's line. The conductor, which is the same for all the cable, consists of a strand of 7 copper wires (No. 22 B. W. G.), weighing 107 lbs. per nautical mile, and having a conductivity 96 per cent. that of pure copper. It is insulated with two coatings of gutta-percha, with alternate layers of Chatterton's compound, and weighs 140 lbs. per N. M. The core



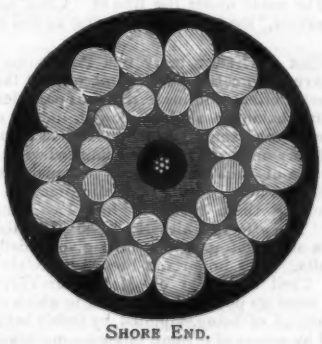
MAIN.

for the main cable is served with a sufficient quantity of jute yarn, and then sheathed with 15 No. 13 B. W. G. Homo iron wire, galvanised. The outside serving consists of two compounded tapes, laid on in an opposite direction. The core for the intermediate cable is similarly served, and then sheathed with 12



INTERMEDIATE.

No. 6 B. W. G. best best galvanised iron wire. Outside serving similar to main cable. The shore end consists of the intermediate cable without taping, and sheathed with 14 No. 1 B. W. G. best best galvanised iron wires. The insulation resistance after one minute's electrification must not be under 250 megohms per N. M., and the guarantee after laying the cable is



SHORE END.

for 30 days, when the insulation resistance must not be less than 225 megohms per N. M. reduced to 75° Fahr. by the co-efficient for G. P. in Clark and Sabine's

"Tables and Formulæ." The breaking strain of main cable is 5½ tons, its weight per N. M. is 1·6 tons, that of the intermediate type 4·31 tons, and the shore end 14·64 tons. The intermediate type when submerged is to overlap the 100 fathom line, and the main cable is to be laid in as nearly as is practicable 300 fathoms, as is the case with the West Coast of America Telegraph Company's cables.

ERICHSEN (AS REPRESENTATIVE OF THE LONDON AGENCY OF THE GREAT NORTHERN TELEGRAPH COMPANY OF COPENHAGEN) *v.* LAST.—This case, adjourned from the 5th inst., was resumed on the morning of the 6th. It was an appeal by Mr. Erichsen from an order made by Justices Lindley, Williams, and Mathew on a case stated by the Income Tax Commissioners for the City of London, and which came on for hearing before their lordships sitting on the revenue side of the Queen's Bench Division. The substantial question raised by the case was whether the company had been properly assessed by the Commissioners at a sum of £40,000 for the financial year ending April, 1877, in respect to the profits of their business as carried on in the United Kingdom, with which the company's chief seat at Copenhagen is connected by three marine cables, the one at Peterhead in Scotland, and the two others at Newbiggin, near Newcastle. For the company it was contended that as no profits were made by them by the transmission of messages by their land lines in the United Kingdom they were not liable to be assessed under Schedule D of the income tax, and in the alternative that if liable to be assessed at all it could only be in respect of the profits from the transmission of messages over these three cable lines. On the other hand, it was contended by the surveyor of taxes that as the company had an agency in this country which received payment direct from the senders of messages at the rate of £70,000, they were liable to the tax on the total profits earned in this country from the transmission of messages. Sir Hardinge Giffard, Q.C., and Mr. Bremner argued the case for the appellant company. Their lordships, without calling on the Attorney-General, the Solicitor-General, and Mr. Dicey, who appeared for the Crown, affirmed the decision of the Court below, and dismissed the appeal, with costs.

CLERKS AND TELEGRAPH LEARNERS AT PROVINCIAL OFFICES.—The Postmaster-General announces that consequent on the amalgamation of the postal and telegraph force at provincial offices, appointments will in future be made under the title of "Clerk and Telegraph Learner," the limits of age being 14 and 25.

THE USE OF ELECTRICITY FOR PURIFYING PORCELAIN PASTE.—Porcelain paste, on account of the origin of the kaolin, often contains ferruginous particles, which give it after baking a slight yellowish tint, or sprinkle it over with small spots when intended to be perfectly white. Every one knows that the finished ware may, in consequence of such defects, lose as much as 50 per cent. of their value. Hence a really practical method for removing these traces of iron has been much desired. The attempts hitherto made of utilising the attractive action of magnets have given chiefly negative results. Two important French porcelain works, that of Creil and that of Mehun-sur-Yévre, have recently fitted up powerful apparatus, in which the electricity instead of being supplied by feeble batteries, is obtained by means of a small Gramme machine, driven by a steam-engine. The apparatus, a model of which was shown at the exhibition, is composed of a powerful horizontal electro-magnet, the poles of which are placed at a small distance from each other. Between these poles is fixed a box, which is thus in a powerful magnetic field, provided that the exciting current is sufficient. The very liquid paste enters at the upper part of this box, and is turned laterally so as to play along the polar sides of the box, and escapes finally by a pipe which leads it to the settling-tanks. It is readily seen that the particles of iron remain fixed to the polar sides of the box. To clean the apparatus the magnetic action is suppressed and a powerful stream of water allowed to traverse the box. This is performed twice daily. One such apparatus suffices for 500 to 600 kilos. of paste daily. About 1 gramme of ferruginous matter is thus extracted from every 12 kilos. of paste.—*Annales Industrielles.*

Proceedings of Societies.

THE PHYSICAL SOCIETY.

AT an ordinary general meeting of this Society, held November 26th, Professor W. G. ADAMS in the chair, Mr. C. VERNON BOYS read a paper "On Integrating Apparatus." After referring to his original "cart" machine for integrating, described at a former meeting of the Society, he showed how he had been led to construct the new machine exhibited, in which a cylinder is caused to reciprocate longitudinally in contact with a disc, and give the integral by its rotation. Integrators were of three kinds, 1° radius machines, 2° cosine machines, 3° tangent machines. Sliding friction and inertia render the first two kinds unsuitable, where there are delicate forces or rapid variations in the function to be integrated. Tangent machines depend on pure rolling, and the inertia and friction is inappreciable, they are therefore more practical than the other sort. It is to this class that Mr. Boys' machines belong. The author then described a theoretical tangent integrator depending on the mutual rolling of two rings, and showed how the steering of a bicycle or wheelbarrow could be applied to integrate directly with a cylinder, either the quotient or product of two functions. If the tangent wheel is turned through a right angle at starting the machine will integrate a reciprocal, or it can be made to integrate functions by an inverse process. If instead of a cylinder some other surface of revolution is employed as an integrating surface, then special integrations can be effected. He showed a polar planimeter in which the integrating surface is a sphere.

A special use of these integrators is for finding the total work done by a fluid pressure reciprocating engine. The difference of pressure on the two sides of the piston determines the tangent of the inclination of the tangent-wheel which runs on the integrating cylinder, while the motion of the latter is made to keep time with that of the piston. In this case the number of revolutions of the cylinder measures the total amount of work done by the engine. The disc cylinder integrator may also be applied to find the total amount of work transmitted by shafting or belting from one part of a factory to another.

An electric current meter may be made by giving inclination to the disc which is for this purpose made exceedingly small and delicate, by means of a heavy magnetic needle deflected by the current. This, like Edison's, is a direction meter, but a meter in which no regard is paid to the direction of the current can be made, by help of an iron armature of such a shape that the force with which it is attracted to fill the space between the holes of an electro-magnet is inversely as

its displacement. Then by resisting this motion by a spring or a pendulum the movement is proportional to the current, and a tangent wheel actuated by this movement causes the reciprocating cylinder on which it runs to integrate the current strength. Mr. Boys exhibited two such electric energy meters, that is, machines which integrate the product of the current strength by the difference of potential between two points with respect to time. In these the main current is made to pass through a pair of concentric solenoids, and in the annular space between these is hung a solenoid, the upper half of which is wound in the opposite direction to the lower half. By the use of what Mr. Boys calls "induction traps" of iron, the magnetic force is confined to a small portion of the suspended solenoid, and by this means the force is independent of the position. The solenoid is hung to one end of a beam and its motion is resisted by a pendulum weight, by which the energy meters may be regulated like clocks to give standard measure. The beam carries the tangent wheels, and the rotation of the cylinder gives the energy expended in foot-pounds or other measure. The use of an equal number of turns in opposite directions on the movable solenoid causes the instrument to be uninfluenced by external magnetic forces. Mr. Boys showed on the screen an image of an electric arc, and by its side was a spot of light whose position indicated the energy, and showed every flicker of the light and fluctuation of current in the arc. He showed on the screen that if the poles are brought too near, the energy expended is less, though the current is stronger, and that if the poles are too far apart, though the electromotive force is greater, the energy is less; so that the apparatus may be made to find the distance at which the greatest energy, and so the greatest heat and light, may be produced.

At the conclusion of the paper, Professor W. G. ADAMS and Professor G. C. FOSTER could not refrain from expressing their high admiration of the ingenious and able manner in which Mr. Boys had developed the subject.

THE SOCIETY OF ARTS.

(*Continued from page* 495.)

GROVE'S GAS BATTERY.

IN 1842, Sir William (then Professor) Grove described the well-known gas battery, which was indeed nothing else than a reversible oxygen and hydrogen battery, in which work had first to be done to produce chemical decomposition.

The rationale of the gas battery is simple enough, provided it be once understood that platinum possesses a power almost unique amongst the metals, of absorbing upon its surface both oxygen and hydrogen gas.

PLANTÉ'S SECONDARY BATTERY.

M. Gaston Planté, to whom, more than to any other experimenter, the real advances in the practical construction of storage batteries are due, very carefully re-examined the whole question of the polarisation of electrodes, using different metals as electrodes, and different liquids as electrolytes, and found that the greatest effective polarisation was produced when dilute sulphuric acid was electrolysed between electrodes of lead. The Planté cell is shown by fig. 1.

The electromotive force developed in a fully charged Planté cell may be as much as 2·38 or even 2·7 volts. A Bunsen battery of small size and considerable internal resistance will take some hours to charge a cell fully, while a dynamo-electric machine may fully charge it in half-an-hour; but the rate of discharge will be alike in each case. M. Planté states that voltametric measurements show that of the whole current 88 to 89 per cent. is given back by the cell. According to M. Géraldy

FIG. 1.

Planté cell containing 1·445 kilogrammes of lead can store 4·983 kilogrammètres of energy, being at the rate of 3·45 kilogrammètres per kilogramme, or 11·329 foot-pounds per pound.

There appears to be an amount of ignorance in the scientific world that is simply inexplicable with respect to the magnificent researches of Planté, and the variety of useful applications to which his accumulator had been put before even the fame of more recent inventions had been noised abroad—before they had even been made at all.

FAURE'S ACCUMULATOR.

In 1880 M. Camille Faure conceived the idea of constructing a secondary battery, in which, though the tedious process of "formation" by Planté's process is modified and shortened, the ultimate result is the same, namely, to produce upon lead plates, immersed in dilute sulphuric acid, a coating of peroxide of lead, that can readily be reduced to the loosely crystalline metallic condition. This M. Faure accomplishes by the device of giving to his leaden plates a preliminary

FIG. 2.

coating of red lead (minium), made up into a paste with water or dilute acid, and painted upon the surface. At first he adopted the spiral form of cell, the two plates being separated by felt or leather. More recently the rectangular form has been reverted to. The present mode of construction is as follows:—Eleven sheets of lead of such thickness as to weigh

about 2 lbs. to the square foot are cut to the size of 12 inches by 10 inches, an ear-piece being left at one corner. Or six sheets are taken, five of them being twice the above size, and folded double in the way shown in fig. 2. These are painted thickly with red lead on

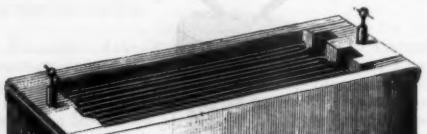


FIG. 3.

both sides, and against each side is pressed a piece of felt, the face of which is also thickly coated with red lead; there being about 17 lbs. of lead and 25 lbs. of red lead altogether. These eleven sheets are placed side by side in a water-tight case, alternate sheets being connected together by the projecting flaps. The general aspect of the cell is shown by fig. 3. The cell is filled up with dilute acid; the total weight being about 50 lbs.

When thus prepared, the cells are "formed" by a process of charging by means of the current of a dynamo-electric machine, the current being sent through them for something like a hundred hours before they are ready for use. The red lead is reduced gradually on one side to the metallic state, and on the other assumes the condition of peroxide; but the cell does not attain its best condition for some weeks. As it is important that the electromotive force of the charging current should not much exceed that of the cells (2·38 volts), it is usual to charge a number of cells in series. The internal resistance of such cells is stated as being less than ·01 ohm. The advantage of this system of construction is not confined to the saving in time of formation: there is the further advantage of thus obtaining a much thicker film of the working substance than in the Planté accumulator; though with the difference that the deposit of peroxide is not so regular in its structure. According to Sir William Thomson, a single cell of the spiral form weighing 75 kilogrammes (165 lbs.) can store 2,000,000 foot-pounds of energy, or one horse-power for one hour. Their action is more economical, however, when the charge is not drawn upon at this rapid rate. Economy in working is found to accompany slow and regular discharge. Five or six hours is a more economical time for discharge, and then the waste is believed not to amount to more than ten per cent. According to Reynier, a Faure cell, containing 56 kilogrammes of lead, can store 210,000 killogrammètres of electro-chemical energy; or at the rate of 3·75 kilogrammètres per kilogramme of lead, or 12·85 foot-pounds per pound of lead. According to M. Géraldy, the figure is slightly less, being only 3·280 kilogrammètres per kilogramme, or 10·760 foot-pounds per pound. Sir William Thomson's data yield the much higher figure of over 30,000 foot-pounds per pound of lead.

DE MÉRITENS' ACCUMULATOR.

Another modification of the Planté accumulator has been devised by M. de Méritens. In this cell the plates of lead are made up of thin laminæ, folded one upon another like the leaves of a book, or more strictly, like the laths of a venetian blind; the whole being soldered to a stouter framework of lead. The object of this arrangement is to secure a greater amount of effective surface. This accumulator has been highly spoken of, and showed admirable results at the late Electrical Exhibition in Paris. No examples have yet been brought to England, and I am not aware of any exact measurements having been made of their power or capacity.

OTHER MODIFICATIONS.

In investigating the properties of secondary batteries, I have tried a number of modifications of the Planté accumulator, with varying success. I have found that almost any oxide or hydrate of lead will answer instead of red lead for the purpose of providing, as in the Faure cell, a material to be converted by a process of formation into the peroxide of lead. Litharge answers well if sufficiently finely divided before being painted on. White lead will even answer, but not so well. Litharge mixed with a small proportion of binoxide of manganese works well. The formation is rapid, but at first the electromotive force is not so high as in the Planté cell. It rises, however, as the process of formation proceeds. The binoxide of manganese is not (see table, page 492, December 1st), so strongly electro-negative a substance as the peroxide of lead. Its presence in the final state would lessen the electromotive force. But happily the manganese gradually dissolves into the acid when its function as an agent to assist the lead in peroxidising is fulfilled and by changing the acid a few times it is finally eliminated. The most satisfactory cells I have yet tried were made by painting the lead plates with a coat of the brown peroxide itself, which is obtainable in commerce, though its cost is about four times that of red lead or of litharge. I find this process by far the most expeditious for making up cells; as indeed might be expected, since it is obviously a stage towards simplification to put on to the lead plates a coating of the very substance which we desire ultimately to produce there. Examination of the plates of a cell in which the process of formation has only just begun, shows that the lead surface must itself be peroxidised and bitten into before the useful action extends to the contiguous portions of oxide or peroxide painted over it, and in some stages a yellow suboxide, probably essentially litharge, appears to be produced as an intermediate product of the reduction of the oxide at the cathode. Of this intermediate yellow product, however, I can find no trace in well-formed cells. As the reduction and peroxidation of the coating only begins where peroxidation of the leaden sheet has begun, the relation of density to maximum polarisation, pointed out in an earlier paragraph of my paper, becomes of extreme importance. Plenty of current, and yet an electromotive force only just exceeding the maximum electromotive force of the cell is the rule for charging in the early stages of formation.

COMPARISON OF PLANTÉ'S AND FAURE'S ACCUMULATORS.

No very reliable comparison between the accumulators of Planté and those of Faure, or of de Méritens, have yet been made. Seeing that in each of these, when completely formed, the materials are the same—namely, lead and peroxide of lead immersed in dilute sulphuric acid—the maximum electromotive force must be eventually the same in each. The resistance of a

cell is simply a question of size and shape. The relative strength of current actually furnished by these cells should therefore merely vary with their dimensions. The presence however, of the felt, and its coatings of red lead, introduces resistance into the Faure cell, and as some recent determinations of M. Achard show, a Planté cell will heat a greater length of platinum wire, and do its work three times as quickly as a Faure cell, whose surface is of the same amount. One would also expect *a priori* that the layers of peroxide, formed upon the electrode by the working of the current itself, should be more regular, and yield currents with greater regularity, than the artificial and more rapidly-formed layers made by painting red lead upon the surface. On the other hand, M. Faure points out that, taking cells of equal size, a larger proportion of the weight in his cell consists of the working substance. The weight of red lead placed in his cells being, for equal amounts of surface, about 26 times as much as the weight of peroxide produced by a "formation" during two years on the plates of a Planté cell of equal size. If this be so, it would imply that, though its resistance might be greater, and its rate of working slower than the Planté cell, the Faure cell would accumulate twenty-six times as much energy in an equal space. These figures require yet to be confirmed, and they are hardly borne out by the statistics of M. Reynier. The Faure cell will do what the Planté cell will not, take in a greater charge, because it has a greater thickness of the working material, and it gives up its charge less rapidly. The Planté cell will do what the Faure cell of equal weight or surface cannot do, namely, produce rapid discharges in currents of greater volume; a property invaluable for the purpose of some of the applications already named.

Application to Electric Lighting by Incandescence.

Faure's cells have already done good work in providing an efficient means of working incandescent lamps, such as those of Swan and Maxim, for domestic purposes. I have the pleasure of showing you to-night the result of passing through a number of Maxim lamps, the current generated by forty of Faure's accumulators. Here are also some of the incandescent lamps of Swan, and of Edison, lit up by the same means. I have to thank the representatives of the various companies for the courtesy that has put at my disposal these means of illustrating my discourse.

Maximum Temperature Attainable by a Cell.

In connection with the subject of obtaining a high temperature by means of a cell, it may not be out of place to point out that the very high electromotive force of these accumulators (about 2·2 volts), exceeding that of any single cell of any other kind, carries with it the possibility of obtaining with such a cell a higher temperature than with any cell of lower electromotive force. This discovery is due to Lorenz, of Copenhagen, who in a very remarkable paper published (in "Wiedemann's Annalen") in August last, upon the relation between the conducting power of metals for heat and for electricity, has shown that the highest possible temperature which a cell can raise any part of its circuit is proportional to its electromotive force. The highest point to which a Daniell's cell, however large, can raise a conductor is, according to Lorenz, 3,327° above the zero of the Centigrade scale. The limiting temperature for a Planté or a Faure cell is 6,927°.

Application to Perfection of the Telephone.

Another application of the secondary batteries which has occured to me, and which on a small scale, I have tried with success, is in connection with telephone transmitters. I propose to increase the power of a transmitter, by employing a multiple microphone, so arranged that a fairly strong current shall pass through each point of contact, and that the current through each contact shall be independent of that through the rest. I therefore arrange all the individual microphones in parallel arc, in the line circuit, but provide each with its own battery. A hundred microphones thus united, and simultaneously acted upon by the voice, will each add their own quantum to the total effect in the circuit; and the result will be loud and distinct speech. But a hundred microphones so arranged, each with its own battery, implies two or three hundred cells. Here the secondary cell comes in with great advantage. I propose to use very small storage cells, each consisting of two small leaden plates, or wires, dipping into diluted sulphuric acid, and properly "formed." Two such cells may be connected with each microphone, and the whole, being already arranged in parallel arc in the circuit, can be kept charged by merely placing across the circuit six Daniell's cells, to be switched off when the transmitter is to be used, and switched on again when the transmitter is no longer required. As yet only a small and rough model of this "secondary circuit transmitter" has been made; but it is extremely satisfactory in its action, and promises to be the first of a useful and important application.

Application to Utilisation of Wind and Water-power.

And, lastly, though by far the most important of all the innumerable possibilities opened out by the storage battery, is its application to the problem of utilising and transmitting the energy derived from wind or water-power. The accumulator will probably play an important part also in the distribution as well as in the storage of power transmitted from a distance, and thus become the ally of the dynamo-electric machine. It is certain that we cannot, with our diminishing coal-fields, long afford to neglect these other sources of natural power. A tenth part of the tidal energy in the channel of the Severn would light every city and turn every loom and spindle and axle in Great Britain. But the power would have to be not only transformed and transmitted, but stored to be available for such ends. Accumulators are therefore a necessary feature in any scheme to utilise the intermittent forces of the tides. Whether the present form will prove adequate to the purpose, the future must decide. There are, as I have sufficiently shown, immense possibilities in store. Electrical railways and electrical tramways are now existing facts. Many months will not elapse—or it will be an eternal disgrace to the first city in the world—before the fetid and poisonous atmosphere of the Metropolitan Railway is replaced by a pleasant and salubrious air, rich in fragrant ozone; and the like revolution will not be long delayed in many quarters where reform is far less imperative. In all these changes the accumulator will have its part to play. A reverse of electrical energy stored till wanted will be a necessary part of all systems for electric distribution, whether for the purpose of lighting, or for motive power.

In conclusion, I would point out how the invention of the accumulator for storing the energy of electric currents has arisen out of the study of an obscure and unpromising detail in the science of electricity—the phenomenon of so-called "polarisation." Regarded by most experimenters merely as a trivial but disturbing fact in the construction of voltaic batteries, to be put down or got rid of by whatever means, it has been developed, and, mainly by the long and patient

researches of one man—M. Gaston Planté—been turned into one of the most fertile and promising features in the development of the science.

[For further information on the subject of the Planté battery, and on a subject closely allied to the secondary battery question, viz., "polarisation," we beg to refer our readers to articles published in the numbers of the Journal for Dec. 15th, 1872; June 15th, 1873; and Dec. 1st, 1875.—EDIT. TEL. JOUR.]

New Patents—1881.

5185. "Electric lamps." E. G. BREWER. (Communicated by A. G. Waterhouse.) Dated November 28.

5198. "Production, conservation, and regulation of electric currents." C. H. W. BIGGS and W. W. BEAUMONT. Dated November 28.

5216. "Improvements in hydraulic motors, and in the application thereof to the production of electric light." J. E. LIARDET and J. DONNITHORNE. Dated November 29.

5221. "Apparatus to be controlled and operated by electricity for stopping trains and giving signals on railways." W. R. LAKE. (Communicated by W. C. Schaffer.) *Complete.* Dated November 29.

5226. "Improved means of joining or coupling branch to main conducting wires or cables for electrical purposes, and of insulating such joints." A. W. BREWTNALL. Dated November 29.

5229. "Improvements in and relating to the utilisation of electricity for lighting or other purposes, and in apparatus therefor or to be used in connection therewith." W. R. LAKE. (Communicated by J. S. Williams.) Dated November 30.

5233. "Improvements in and relating to the utilisation of electricity for lighting or other purposes, in apparatus therefor or connected therewith, and in means for producing or manufacturing such apparatus." W. R. LAKE. (Communicated by J. S. Williams.) Dated November 30.

5261. "Construction of secondary batteries." H. E. NEWTON. (Communicated by E. Volckner.) Dated December 1.

5272. "Electric lamps." W. F. KING and A. B. BROWN. Dated December 2.

5286. "Improvements relating to the production of electric light in electric lamps, in the means for and methods of manufacture of the carbons and incandescing conductors for the same." A. R. SENNETT. Dated December 3.

5295. "Improved mechanism for regulating the feed of electrodes in electric lamps." H. E. NEWTON. (Communicated by A. J. Gravier.) Dated December 3.

5303. "Construction of telephones." J. BURTON. Dated December 5.

5309. "Preparation of materials to be employed for the purposes of electric insulation." J. A. FLEMING. Dated December 5.

5316. "Apparatus for lighting railway and other carriages by electricity." R. LAYBOURNE. Dated December 5.

5322. "Electric accumulators." J. IMRAY. (Communicated by J. Carpentier and Odo Pezzer.) Dated December 6.

5338. "Secondary batteries." D. G. FITZGERALD, C. H. W. BIGGS, and W. W. BEAUMONT. Dated December 6.

5360. "An improvement in or connected with telephone transmitters." E. H. JOHNSON. Dated December 7.

5367. "An improved machine for covering or coating insulated electrical conductors or conducting wires with lead." W. R. LAKE. (Communicated by H. S. Maxim.) Dated December 8.

5368. "An instrument or apparatus to be used as a photometer, actinometer, and sensitometer." J. D. MUCKLOW and J. B. SPURGE. Dated December 8.

5385. "Improvements in telephones and in lightning arresters therefor and in other purposes." G. W. FOSTER. Dated December 9.

5396. "Electric lighting." C. F. and F. H. VARLEY. Dated December 9.

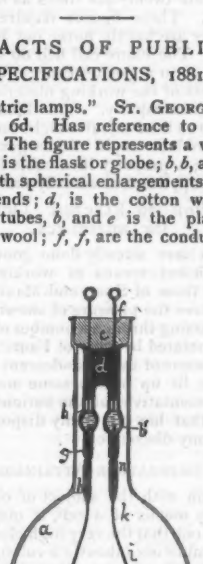
5400. "Electric light lamps or lanterns." J. ROWAN. Dated December 9.

5407. "An improved manufacture of compounds for electrical insulation." W. ABBOTT and F. FIELD. Dated December 10.

5418. "Arrangements of electrical apparatus on railway trains." J. E. LIARDET and J. DONNITHORNE. Dated December 10.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

1543. "Electric lamps." ST. GEORGE LANE FOX. Dated April 8. 6d. Has reference to incandescence electric lamps. The figure represents a vertical section of a lamp. *a*, *a*, is the flask or globe; *b*, *b*, are the mercury tubes formed with spherical enlargements or bulbs, b^1, b^1, at their lower ends; *d*, is the cotton wool above the mercury in the tubes, *b*, and *e* is the plaster of Paris over the cotton wool; *f*, *f*, are the conducting wires or



terminals; *g*, *g*, are the platinum wires fused into the bottoms, *n*, *n*, of the tubes, *b*, and extending up into the mercury in these tubes; *h*, *h*, are the cylinders or blocks of plumbago or carbon with holes drilled in their upper ends so as to allow of their being forced over the lower ends of the wires, *g*, as shown, the wires being cemented in the cylinders by Indian or Chinese ink; *i*, is the electric bridge, the ends of which are inserted into holes

or slits in the lower ends of the cylinders *h*, *h*, and they are similarly cemented with Indian or Chinese ink. The ink is applied to the ends of the bridge, *i*, and dabbed round the holes in the cylinders, as seen at *k*, *k*.

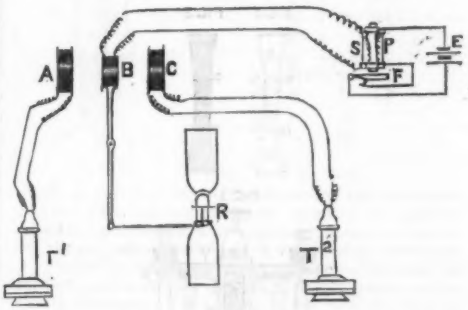
1550. "Protecting magnetic needles from local attraction." JOHN SACHEVERELL GISBORNE. Dated April 9. 6d. The magnetic needle is surrounded with several series of concentric segments, or other suitably shaped pieces of iron, which also extend underneath the needle and meet in the centre as close as possible to the pivot upon which the needle is mounted; these iron segments or other shaped pieces are not in touching contact but are isolated from each other by intervening pieces of ebonite or other suitable insulating material. By thus surrounding the needle it is insured that any polarisation of the iron, even should it occur, shall not affect the magnetic needle, and yet that the needle shall itself be effectually protected from the influence of any local attraction.

1577. "Electric telegraphs," &c. JOHN HOPKINSON and ALEXANDER MUIRHEAD. Dated April 11. 2d. Relates to improved methods of employing dynamo-electric machines for producing the electric currents used in telegraphy, and for other similar purposes. A secondary battery or a series of voltameters, or in some cases a condenser in combination with dynamo-electric machines (sometimes called electro-magnetic or magneto-electric machines) are used to correct the inconvenience sometimes experienced from the self induction of the latter when used alone. (*Provisional only.*)

1596. "Electric lamps." A. W. L. REDDIE. (A communication from abroad by Hermann Sedlaczek and Franz Wiknlill, of Leoben, Austria.) Dated April 12. 6d. Relates to improvements in the means of regulating the feed of the electrodes in that class of lamps in which the holders of the said electrodes are supported on fluid contained in closed vessels communicating with each other at their lower parts. This improved regulation of the feed of the electrodes is effected either by connecting directly or indirectly a centrifugal governor upon the motive power engine with a hollow cock or piston of peculiar construction, whereby the passage of the fluid from one vessel to the other may be perfectly controlled, or by means of a novel arrangement of electro-magnet whereby a piston is caused to operate with great delicacy in controlling the passage of the fluid from one vessel to the other.

1613. "Electrical signalling and tell-tale apparatus for watchmen," &c. W. R. LAKE. (A communication from abroad by Isaac Towle Campbell, of Boston, America.) Dated April 13. 8d. Relates to electric alarm and registering apparatus intended for the use of, and as a guard upon watchmen, to indicate any neglect of duty.

1624. "Electric telegraphs." ALEXANDER MUIRHEAD and HENRY ALFRED CHARLES SAUNDERS. Dated April 13. The object of this invention is to facilitate the reception and retransmission of messages on long submarine cable circuits. A double telephonic repeater is employed in connection with the suspended coil or magnet of the receiving instruments, and there is introduced between one cable and another, automatic translating apparatus operating by light or radiant energy. The double telephonic repeater consists of three independent coils, A, B, and C, as shown in plan by the figure. The middle one, B, is suspended and movable between the other two, A and C. It is connected to the movable coil, B, of a Thomson's recorder and therefore responds to the fluctuations of the cable current in the latter. The other two coils, A and C, of the series are fixed and connected with two separate telephones, T^1 and T^2. A rapid series of currents from a battery, E, is caused to pass through the suspended coil by means of a tuning fork, F, or other make and break arrangement. Sound will be produced in the telephones varying in intensity with the proximity of the suspended coil to the fixed coils. The nearer the suspended coil to either fixed coil the louder will be the sound in the corresponding telephone. The operator placing a telephone to each ear reads by sound the message transmitted. For the sake of lightness the suspended coil, B, is constructed of aluminium wire. For automatic translation between submarine cables an arrangement is employed in which an electrical circuit is affected by radiant energy. Selenium (or other substance whose electrical resistance is affected by radiant energy) is extended into a band, like the scale of a reflecting galvanometer, and the movable index of the receiving instrument controls a beam of light or



heat, and by its motion determines the extent to which the selenium is affected by the beam. Variation of electromotive force proportional to the amount of movement of the index is thus brought about in a circuit in which a relay is included. Two relays of the Brown and Allan type are employed, *i.e.*, relays in which the contact maker moves with the first rise and the first fall of potential. These relays are placed in close circuit with the selenium in the following manner:—One terminal of each relay is connected to the ends of the selenium, and the other terminals are connected to the middle. In the local circuits of these relays are placed electro-magnets and batteries. The contacts made by the relays are employed to actuate translating levers in connection with the cable.

1636. "Apparatus for producing motion by electricity," &c. ST. GEORGE LANE FOX. Dated April 14. 6d. Has special reference to apparatus in which an electrometer or electro-dynamometer connected between the electric mains and the earth is employed to actuate a motor which is caused to control the action of the electric generator or generators, or to control the commutators or secondary batteries, or to control the action of rheostats or resistances, or for other purposes in systems of applying or distributing energy by electricity through mains, submains, and branches for lighting or other purposes. As the electromotive force in the mains rises above or falls below a given limit, the electrometer or electro-dynamometer completes a circuit, and sets up a current through one or other of two contact pegs which are respectively connected with two electro-magnets of the motor.

1653. "Electric lamps." J. H. JOHNSON. (A communication from abroad by the Société La Force et la Lumière Société Générale d'Electricité of Brussels.) Dated April 14. 8d. Has for its object the production

of an electric lamp which shall give light by incandescence, and offer the requisite resistance to the passage of the current without the necessity for the employment of long and very attenuated conductors, and this object is effected by means of the improvements hereinafter described. Fig. 1 is an elevation, and fig. 2 a corresponding longitudinal section of a divided incandescent conductor, constructed according to the said invention, and adapted for use in a lamp from which the air is excluded. Fig. 3 shows the lamp for the conductor, illustrated in figs. 1 and 2. Referring to figs. 1 and 2, *a* is an incandescent conductor divided into a number of sections, *s*, arranged between two supports or contact pieces, A and B, which are caused to exert a certain amount of pressure on the divided conductor, *a*. The conductor, *a*, is composed of a substance or substances of a highly refractory nature, such, for

FIG.1 FIG.2

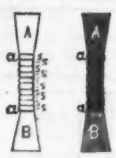
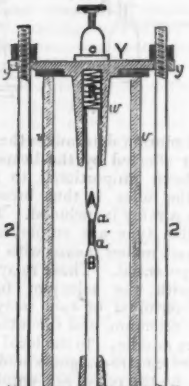


FIG.3



example, as graphite, retort carbon, artificial agglomerated carbon, carbon made from wood, paper, or other calcined organic matter or metals, which are the most difficult of fusion, such as iridium, osmium, ruthenium, and the like. The contact pieces, A and B, are either made of the same materials as the divided conductor, *a*, or of a material of a less refractory nature, such, for example, as platinum.

1670. "Electric lamps." GEORGE SYLVESTER GRIMSTON. Dated April 16. 6d. Relates chiefly to that description of electric lamps in which the regulation of the carbons is effected by the differential action of two coils or solenoids of different resistance, of which the coil of low resistance is in the lamp circuit, while the coil of high resistance is connected to the external circuit only. The soft iron core or cores, which is or are acted upon by the two coils or solenoids above referred to, carries an arm or bracket, through apertures in which passes the carbon holder, which can descend freely through the apertures unless otherwise held. To the bracket is pivotted an excentric or cam-shaped piece provided with a projecting arm, the weight of which tends to turn the excentric or cam so as to press the carbon holder against one side of the apertures through which it passed, and the carbon holder is thus held in the bracket, and can only move up or down with the same, according as the core is actuated by the differential coils. When by the burning away of the carbon, and the consequent increased action of the coil of high resistance, the core has caused the bracket and carbon holder to descend to a certain point, the arm of the cam or excentric comes in contact with a stationary adjustable stop, and the further descent of the bracket consequently causes the cam to be turned, so as to release the carbon holder, which then descends by gravity through the bracket. On the current now passing to a greater extent through the coil of low resistance, consequent on the near approach of the carbons, the core is actuated so as to raise the bracket, and the arm of the cam being now again free to turn the cam so as to nip the carbon holder, this is raised again with the bracket, so as to bring the carbon to the proper distance for producing the electric arc.

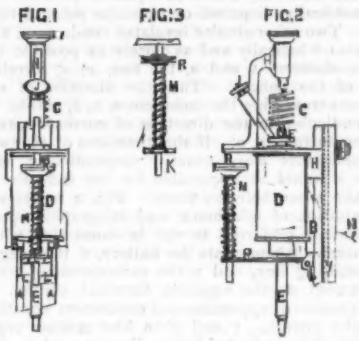
1676. "Secondary electric or galvanic batteries." J. H. JOHNSON. (A communication from abroad by Camille Alphonse Faure, of Paris.) Dated April 16. 6d. Relates to improvements in the construction and arrangement of secondary, electric or galvanic batteries constructed on what is known as Faure's system as well as Planté's system, or any other battery of the same class. In carrying out this invention the lead plate acting as the support or the surface of the support is coated or covered in the first place by means of electrotypy, disintegration, or deposit in the form of paste with an active substance or composition, which may consist of either red lead or other oxide of lead or of an insoluble salt of lead, or again of a metallic salt producing the effect desired. This active composition is afterwards covered with felt, cloth, asbestos, cardboard, or paper, canvas, or any other porous material that is not liable to be injured by the use to which it is applied. The object of this porous substance is to maintain the active composition in its place against the support. It is obvious that wire gauze made of lead or other suitable wire may also be employed for this purpose. It then becomes necessary to attach this porous covering employed for holding up the composition to the support, and this is effected by various means according to the nature of the support, that is to say, by means of leaden rivets, or rivets of other suitable material, or material which is not liable to produce objectionable products under the action of the liquid in the battery.

1679. "Telephonic and telegraphic exchange systems," &c. JOHN NORCROSS CULBERTSON and JAMES WALLACE BROWN. Dated April 16. 6d. Has for its object improvements in telephonic and telegraphic exchange systems, and in insulating and mounting the conducting wires used for telephonic and telegraphic communication. In working the telephonic apparatus it has been found desirable to use complete metallic circuits, and endeavours have been made to arrange what are known as central exchange systems to work in this manner, but up to the present time no satisfactory arrangement has been applied for the purpose. This object is effected in the following manner:—Switch boards are employed of the ordinary construction with a number of insulated parallel bars, to which conducting wires leading to the distant stations are attached. At

right angles to these wires are a number of other insulated bars, to which any one or other of the first-mentioned bars can be coupled by the insertion of a metallic peg at a point where the bars cross one another. One of the cross bars of each switch board is ordinarily coupled to earth. All the return wires from the distant stations are connected to this bar, and where a number or series of similar switch boards are used all these bars of the several switch boards are coupled together by a conducting wire. Thus the return circuit from all the distant stations will be conveyed through this wire, and the coupling of the wire from one station to the wire leading to another station will be effected by shifting a single peg only, that is, one peg for each station.

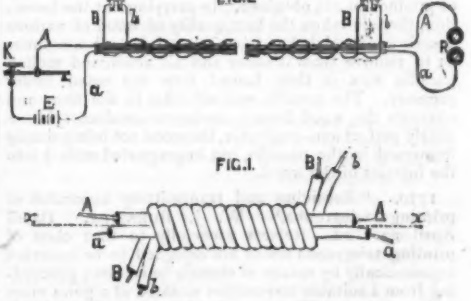
1683. "Electrical apparatus for signalling on railways." A. M. CLARK. (A communication from abroad by Augustin d'Auriac, of St. Flour, France.) Dated April 16. 8d. Relates to electrical apparatus for establishing communication between trains in motion and between trains and stations, whereby to prevent collision between two trains running at different speeds upon the same line of rails between two stations. The apparatus is based on the principle that any good conductor of electricity, when in contact with another body traversed by an electric current, will give passage to the current at the instant of contact, and cause it to take another path through a conducting wire suitably arranged. The apparatus carried in a signalling van comprises a battery, a transmitter, and a receiver, and the line conductor is a rail made of three bars of galvanised iron. Upon this rail runs a contact wheel of wood with a metal tyre, which receives the currents traversing the rail and transmits them through a conducting wire to the receiver, the wheel being kept in contact with the rail by a spring at all speeds.

1685. "Electric lamps or regulators." A. M. CLARK. (A communication from abroad by Jean Marie Anatole Gerard-Lescuyer, of Paris.) Dated April 18. 8d. Relates to various modifications or arrangements of electric lamps or regulators, in which a small arc is produced for effecting the division of the electric light. In figs. 1 and 2, A, represents a brass or copper guide, upon which slides a bracket or frame, B, C, carrying a solenoid, D, made of fine wire, through which passes freely the brass carbon holder, E, to the upper end of which is fixed a soft iron armature, F. The carbon holder, E, is suspended by a spring, G, from a small bracket, H, carried on the plate, C, so that the armature is a few millimetres above the upper pole of the solenoid. The tension of the spring may be regulated by a screw, I, and the distance between the armature, F, and the pole of the solenoid is regulated by a screw, J, mounted obliquely. At the lower end of the sliding bracket, B, a second armature, K, is pivotted, and has a short arm, or jaw, L, which is caused by the pressure of a spring, M, on the end of the arm, K, to bind against the guide, A, the stress of the spring, M, being regulated by a screw, R. The upper carbon is fixed in the carbon holder, E, and passes between guide rollers, *a*, by which it is electrically connected with the lamp frame, so as to reduce the length of carbon traversed by the current The lower carbon, of much larger diameter than the upper one, is fixed in line therewith. This carbon is consumed very slowly, and needs readjustment only when the upper carbon has been entirely consumed. It is fixed in a clip or holder, s^1, carried by an arm, O, insulated from the lamp frame. The solenoid, D, is placed in derivation by means of a spring, shown in dotted lines, sliding in contact with a plate, *y*, fixed in the groove, X, insulated from the body of the lamp, and connected with the arm, O. The action is as follows:—The current enters at N, and the carbons being separated passes by the derivation through the wire of the solenoid, D, excites it, and causes the armature, K, F, to be attracted. The oscillation of the armature, F, releases the grip of jaw, L, and allows bracket, B, to descend. As soon as the carbons come in contact the current passes through them, the coil, D, becomes inert, and the two armatures are withdrawn by their springs, the one causing the jaw, L, to again bind against the



guide, A, and thus arrest the descent of the bracket, B, and the other causing the upper carbon to be suddenly raised or separated from the lower one, thereby establishing the arc, whose amplitude is regulated by the screw, J. Should the resistance of the arc become too high, the current again traverses the coil, D, and the upper carbon slowly descends. The feeding of the carbon is effected by continuous and insensible vibrations without jerks, so that the light is constant. In order to increase the effect of these vibrations, a pallet may be mounted on the armature, K, having small knobs of metal on its ends, as shown in fig. 3. This regulator may also be inverted, if desired, and two or more may be combined in a single lamp.

1696. "Telegraphy." SYDNEY PITT. (A communication from abroad by Orazio Lugo, of New York.) Dated April 19. 6d. Has for its object so to organise



the apparatus that two or more independent electric circuits may be established through a single cable or compound conductor, each of which may be utilised for work independent of the others, so that electric currents of different character or independent sets of signals may be simultaneously sent through the same compound

conductor. Fig. 1 represents the organisation of conductors forming two telegraph or telephonic circuits organised in accordance with the principles of this invention, and fig. 2 is a theoretical diagram illustrating the application of the invention to a telegraphic and a telephonic circuit. Two metallic conductors, A and *a*, are shown in fig. 1, each enveloped in the ordinary manner in insulated coatings of any suitable material, which are placed parallel to and symmetrically disposed on opposite sides of the line, *x*, *x*. Two other similar insulated conductors, B and *b*, are wound helically and as closely as possible around the conductors, A and *a*, the line, *x*, *x*, forming the axis of the helices. Thus the direction of electric currents traversing the conductors, B, *b*, will be nearly perpendicular to the direction of currents traversing the conductors, A, *a*. If the directions of the two sets of conductors were exactly perpendicular to each other, it would be impossible for any inductive effect to take place between them. Fig. 2 represents the organisation of telephonic and telegraphic apparatus which it is preferred to use in connection with this invention. E represents the battery, K the telegraphic transmitting key, and R the corresponding receiving instrument at the opposite terminal station. This organisation of apparatus and conductors constitutes a metallic circuit. T and T' in like manner represent two telephones adapted for sending or receiving, placed at opposite terminal stations, and included in the metallic circuit formed by the direct and return conductors, B and *b*.

1745. "Electrical batteries." C. D. ABEL. (A communication from abroad by Paul Jablochkoff, of the Société Générale d'Electricité (procédés Jablochkoff), of Paris.) Dated April 22. 6d. Relates to an improved construction of electrical battery, which has for its object to accumulate electricity and which operates according to the principle of the secondary batteries. The invention consists in rendering the electrodes, whatever their nature and form may be, more apt to become polarised by covering them with oil or other fatty, oleaginous, or resinous bodies, in particular the hydrocarbons and mineral oils, such as naphtha and its compounds. (*Provisional only.*)

1762. "Preparation of materials for electric insulation." JOHN AMBROSE FLEMING. Dated April 23. 6d. Relates to improvements in the preparation of materials to be employed for the purposes of electric insulation, whereby advantages in economy and facility of production are obtained. In carrying out the invention, there is taken the best quality of wood of various descriptions which has been treated in such a manner as to remove from it water and all acids, and melted paraffin wax is then forced into the wood under pressure. The paraffin wax solidifies in the fibre, and converts the wood from a moderate conductor into a nearly perfect non-conductor, the wood not being simply immersed in the paraffin, but impregnated with it into the interior of the wood.

1770. "Receiving and transmitting apparatus of printing telegraphs." W. J. BURNSIDE. Dated April 23. 2d. Relates especially to that class of printing telegraphs which are designed to be operated automatically by means of electric pulsations proceeding from a suitable transmitter situated at a point more or less distant. The general object of the invention is to increase the rapidity and certainty of operation of such an apparatus, and to provide improved means of maintaining the synchronism between the transmitting cylinder at the sending station and the type wheel at the receiving station or stations. (*Provisional only.*)

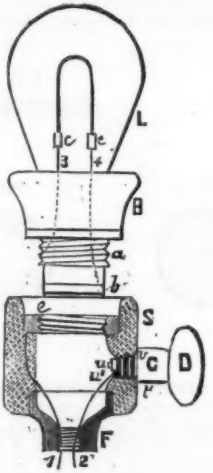
1783. "Measuring electric currents." E. G. BREWER. (A communication from abroad by Thomas Alva Edison.) Dated April 25. 6d. Relates to a current measuring apparatus in which there is used as the basis of the meter a simple electro deposition cell placed in a shunt to the main circuit, so arranged, that only a definite fraction of the entire current shall pass therethrough, which may be effected by placing a suitable resistance in the main conductor, at a point between the unions of the conductors of the shunt circuit thereto. At stated intervals the cathode plate is taken from the cell and weighed, the increase in result indicating the amount of current which has passed therethrough, which, multiplied by the denominator of the fraction representing the portion of current shunted, gives the amount consumed in the entire circuit to be measured. Upon the passage of the current through the cell, the fluid therein is heated, it may be to a very small extent, still there is a heating effect therein. This diminishes the resistance of the cell, and consequently a proportionately increased amount of current passes therethrough, making an appreciable source of error. To remedy this, a resistance should be used in the cell circuit, equally susceptible to the heating influences of the current, but which increases in resistance as it is heated. By this means, as the resistance of the cell is diminished, the artificial resistance in its circuit is increased, so that the entire resistance of the shunt or electro-depositing circuit is maintained constant. A resistance of fine copper wire answers well for this purpose.

1787. "Dynamo-electric machines." A. M. CLARK. (A communication from abroad by Hans Jacob Müller and Alexander Levett, of New York.) Dated April 25. 1s. 4d. The chief object of this invention is to provide a new and improved dynamo-electric machine, which is so constructed that a series of separate and independent currents can be produced, of which one may be used to excite the field magnets, and at the same time perform work in the external circuits, whereas the other currents perform work in the external circuits only, and these different currents from the same machine may be of various degrees of intensity.

1802. "Electric lights," &c. PETER JENSEN. (A communication from abroad by Thomas Alva Edison.) Dated April 26. 10d. In a system of electric lighting, where the lamps used consist of an incandescent conductor hermetically sealed in a glass inclosing globe, it is desirable that the lamp and its supporting socket should be so constructed that the lamp may be readily removed from or placed in the socket, and that at the same time by the act of placing in or removing the lamp from the socket the appropriate circuit connections to the conductor, subject however and only to the control of a suitable circuit controller for throwing the current through the lamp when desired, shall be completed.

In the figure, which shows the invention by which this requirement is accomplished, S is the socket, made of insulating material hollowed out to receive the neck, B, of lamp, L. The socket is provided with the screw threaded end, F, made of a separate piece attached to the socket, or made integral with the socket, for attachment to any suitable support or fixture. Secured in the socket is the circuit controller, C, formed as follows:—*t*, its stem, is a cylinder of insulating material, screw threaded at one end, *v*, for its securement to S. The outer end of the cylinder is a head, *o'*, solid, except for an aperture, through which passes the rod, *x*, carrying the contact point, *u*. Upon the rod, *x*, is a head or washer, *u'*, filling the inner end of the cavity in *t*, and forming a bearing, against which takes the spring, *s*, wound around *x*, and serving to force *u*, *u'*, out from *t*. Upon the head, *o'*, of *t*, are cut the diametrical grooves,

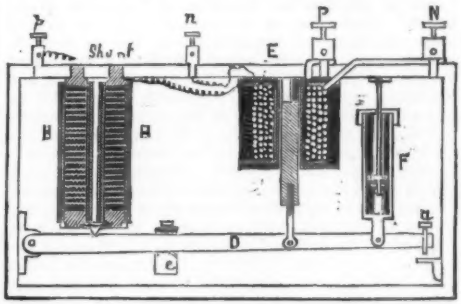
E, E', of which one, E, is much deeper than the other, as shown, both having inclined or bevelled sides. A pin, *y*, attached to and extending out from, *x*, takes in these grooves. Upon its extreme outer end the rod, *x*, should be provided with an insulating thumb piece, D. From this it will be seen that as D is turned the stress of the spring, *z*, pulls *y* into one of the grooves, and holds it there, unless force be applied sufficient to raise it therefrom, so that when the pin, *y*, falls into E, the



extra depth thereof permits the spring to force *u* out further than when the pin takes in E'; and these distances are so proportioned that when the pin, *y*, is in E, the circuit shall be closed, and broken when the pin, *y*, is in E'. Two metal bands or rings, *a*, *b*, are put upon the neck, B, one of which, *a*, is formed into a male screw thread; from these bands, wires, 3, 4, lead to the clamps, *c*, *c*, of the incandescing material. Upon the interior of the socket is the metal band, *e*, formed into a female screw thread, to which is connected the main conductor, 1, the other main conductor, 2, being connected to, *c*. The act of placing B within S, and fastening it therein by the screws, *a*, *e*, completes also the circuit connections, one branch then being, 1 . *e* . *a*, 3 . *c*, the other being, 2 . C . *b*, 4 . *c*.

1826. "Galvanic soles for shoes and boots." G. W. VON NAWROCKI. (A communication from August Wienand, of Pforzheim, Germany.) Dated April 27. 4d. The soles are mainly composed of alternate strips or pieces of zinc and copper united by brass eyelets. Applied as a "sock" to be placed inside a boot or shoe, the underside is covered with leather, and the upper side with woollen material. The metal parts are united to the leather part by means of eyelets, rendering the sole or sock durable, and facilitating the exhalation of vapours from the wearer's foot. The acid animal exhalations produce with the zinc and copper parts a gentle electric current, which is of great value in rheumatic affections. Instead of copper and zinc, other substances of opposite electric or galvanic properties may be used.

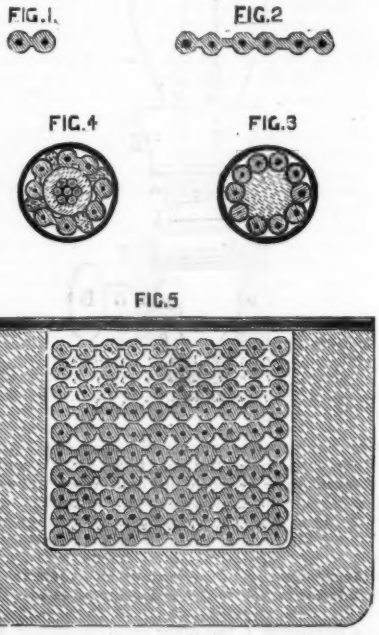
1835. "Current-governors for dynamo-electric machines." H. J. HADDAN. (A communication from abroad by Charles F. Brush, of America.) Dated April 28. 6d. Relates to dynamo-electric machines, and has for its object the adaptation of such machines to variable external conditions without variation of the speed at which their armatures are rotated, but by variation of the intensity of the magnetic field, and this by means not directly depending on the volume of current circulating in the external circuit. In the figure, H, H, are piles of carbon or other suitable plates inclosed loosely within glass, porcelain, or other suitable insulating tubes or supports. The piles rest upon blocks of carbon or metal electrically connected, carried by a bar of wood or metal, which is pivotted to and supported by the lever, D. The upper ends of the insulating tubes are loosely closed by plugs of carbon or metal supported by the frame of the apparatus and insulated from each other. The tubes or supports inclosing the piles, H, may be of metal (to absorb and radiate the heat generated) lined with mica or other insulator. The magnet-helix, E, consists of two separate coils of wire, one located in the shunt circuit, the other in the main circuit, both as shown. These two coils or helices may be arranged in various manners in relation to each other. Either may occupy the outer position or may cover exclusively one line of the spool. Two compound helices, E, with corresponding cores of iron may be employed to increase the effect. Within the helix, E, is a movable iron core pivotted to the lever, D. This lever pivotted at one end, as shown, also carries a movable and therefore adjustable weight, *c*. (An



adjustable spring may be substituted.) The free end of the lever, D, also carries the body of a dash-pot, F, and a thumb-screw, *d*, by which the downward movement of the lever is adjusted. The piston of the dash-pot, F, is attached to the frame-work of the apparatus by means of its rod, as shown, and is provided with a valve opening downward. When the dash-pot is filled with glycerine or other suitable liquid its piston and valve allow the lever, D, to move downward freely but retard its upward movement. The valve in the piston is not essential, but is desirable, as will be shown later. The operation of the whole device is as follows:—The binding-posts, *p*, *n*, forming the terminals of the shunt circuit, are connected with the field-magnets of a dynamo-electric machine in the manner explained in the previous letters patent referred to. The course of the shunt-current is then from the post, *p*, through to the piles, H, H, outer portion of helix, E, to post, *n*. The binding-posts, P, N, are put in the main or working circuit of the machine, as was also explained in the said prior patent, but in such a manner that the main current shall pass through the helix, E, in the same direction as the shunt-current. The weight, *c*, is so adjusted that when the machine is working to its full capacity and the normal working-current is passing through its portion of the helix, E, the inclosed iron core, lifted by the axial magnetism developed in the helix, shall just sustain the lever, D, and parts con-

nected therewith while subjecting the piles, H, to little or no pressure. Since in this condition of affairs the piles, H, H, perform no function, the circuit through them may be entirely broken by dropping the lever, D, sufficiently. This however is not essential. The office of the thumb-screw, *d*, is now apparent. If now the resistance of the working circuit of the dynamo machine be lessened from any cause the current will be correspondingly increased in the helix, E, and the inclosed core will be drawn upward, raising the lever, D, and subjecting the resistance-piles, H, to a pressure corresponding to the increase of current in the main circuit. Current will then be shunted from the field-magnets of the dynamo machine until the main current is reduced to nearly its original strength. Some increase of current strength is, however, required in order to maintain a suitable pressure in the piles, H, H. It is in order to render this necessary excess of main current as small as possible that the shunted current is made to pass through a portion of the helix, E. The shunted current thus assists in maintaining a suitable pressure on the resistance piles, H, H, and the apparatus is thereby enabled to respond to very much smaller variations in the strength of the main current than it otherwise could do. When the carbon piles, H, H, are subjected to pressure, their conducting power increases less rapidly than the pressure applied. Hence the apparatus is not liable to get into the condition of "unstable equilibrium." The office of the dash-pot, F, has already been described, but the function of the valve in its piston has not been indicated. Suppose a number of voltaic arc lamps are operated in the main circuit, and the latter, as often occurs in practice, becomes for an instant broken, then, owing to the valve in the piston-rod of the dash-pot, the lever, D, drops at once, and the shunt resistance increases, so that when the carbons in the lamps have come together and completed the main circuit again the full power of the dynamo machine will be available to separate the carbons in the lamps, and owing to the slow upward motion of the lever, D, allowed by the dash-pot sufficient time is given for the carbons in the lamps to become fully separated before the shunt can act; but if the lever, D, had not been allowed to fall materially during the instant the main circuit was broken the abnormally great current developed when the circuit was closed, and before the carbons in the lamps had time to separate, would further raise the lever, D, and unfit the dynamo machine for developing its normal current. An appreciable length of time would then be required for the resistance apparatus and the lamps to again adjust themselves. Again, if the resistance of the main circuit is suddenly increased, the valve in the dash-pot allows the lever, D, to fall at once, and thus the dynamo-machine is quickly adapted to the new condition of circuit.

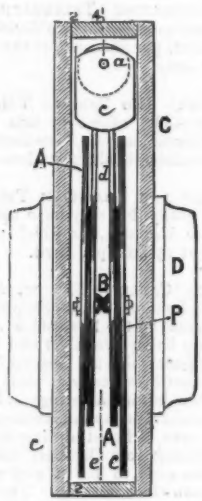
1873. "Telegraph cables," &c. W. T. HENLEY. Dated April 30. 6d. According to this invention, combined conductors are constructed for telephonic, telegraphic, and other purposes as hereinafter described, by which means additional strength and security is obtained, and the disturbing effects produced by induction from wire to wire, obviated. The wires are insulated with any suitable material, but preferably with "ozokerited" india-rubber. The wires are inclosed by means of rollers or dies in the insulating material in pairs, or any further number, as shown by the figures. Fig. 1 shows a single pair; fig. 2, three pairs united, the spaces between each pair being greater than between the wires of each pair; this is to prevent the induction when using the metallic circuit for telephone purposes. To obtain tensile strength, one wire of each pair is made of steel, by preference galvanised or zinc coated; this should be as much larger than the copper wire in same circuit as its electrical resistance is greater, so that the electrical conductivity of the pair of wires, steel and copper, should be as nearly as possible equal. Fig. 1 shows a pair of wires thus constructed. When laid underground in pipes or troughs, the wires may be all copper, and a number be combined in a trough, as in fig. 5, where one hundred wires are shown in a wooden trough covered with an iron lid, forming one hundred separate telegraphic circuits, as the metallic circuit is not required for the telegraph, neither does the induction interfere, as the



telegraph instruments are not so sensitive as the telephone. Fig. 4 shows some of the twin circuits for the telephone, laid up spirally round a central steel strand covered with yarn, and each pair is kept farther apart by an intervening tarred cord. Fig. 5 shows the wires of copper and steel insulated, laid up in pairs round a central core of hemp or other suitable material. In this case the insulated steel wires, whilst forming part of the circuit, give the necessary tensile strength without the central steel strand.

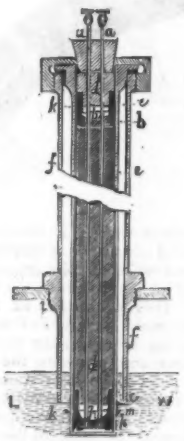
1885. "Electric telephones." WILLIAM MAIN, of America. Dated May 2. 6d. Relates chiefly to battery transmitting telephones, but it is also in part applicable to receiving telephones. Its object is to secure the accurate and faithful transmission and reproduction of vocal sounds, even those which are faint and distant, without change of tone, and without transmitting also the external rumblings and inaudible vibrations which frequently occur coincidently with speech. In the figure A, A, are two "acoustic-vibrators," which answer to the diaphragm in other telephones, but differ therefrom in being freely suspended from above, leaving their other edges free to vibrate. Both are hinged to a rod or axis, *a*, whose ends rest in non-

vibratory cushions of felt or rubber; *c*, *c*, are weights of lead or other heavy metal hung on the rod, *a*. Each acoustic-vibrator, A, is constructed of two thin light boards or plates, *d* and *e*, of resonant wood, the plate, *d*, being hinged at its upper edge to the rod, *a*, and the plate, *e*, being borne by the plate, *d*, through the medium of a thin wooden ring, *f*, which separates them slightly, so that a thin layer of air is confined between them. The plate, *d*, has a central sound-opening, *g*, communicating with the air-space. B, B, are the resistance-varying contacts or electrodes, one being fastened to each plate, *e*, so that the two project toward each other through the openings, *g*, *g*. These electrodes



are long enough to separate the acoustic-vibrator slightly so that the tendency of the vibrators to hang directly beneath the axis, *a*, causes them to press the electrodes lightly but firmly together. This pressure remains always uniform, requiring no adjustment. The electrodes are by preference made of platina and carbon respectively, but other substances may be used. They are connected by wires, *i* and *j*, to the local battery and induction-coil in the usual way.

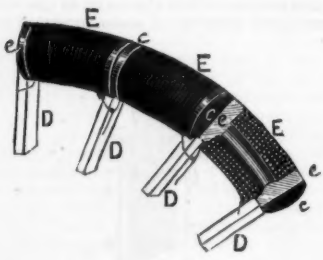
1953. "Electric apparatus for signalling the lowest height of water level, and maximum temperature in steam boilers." CARL PIEPER. (A communication from Richard Schwartzkopff, of Berlin.) Dated May 5. 6d. Consists in an apparatus by means of which an electric current is established for the purpose of giving a signal or of causing any other suitable effect when the lowest admissible water-level or a certain maximum temperature, resulting either from an excess of pressure or from retarded ebullition, occurs in a steam-boiler, the electric contact being made by the melting of an easily fusible metal. The apparatus presented by the figure consists of two metal tubes, *e* and *f*, of different diameter, the narrower tube, *e*, being inserted concentrically into the wider tube, *f*. Both tubes are so connected together at their upper end that the annular space between them is hermetically closed at the top, whereas the inside tube, *e*, which should project with its lower end from the outside tube, *f*, is closed at the bottom. The tube, *f*, is fixed in such a manner in the crown of the boiler that its lower edge is at the height of the lowest admissible water-level, L, W. Its length outside of the boiler must be such as to allow its upper end to remain comparatively cool, four feet being ordinarily sufficient for this purpose. Within the inside tube, *e*, there are two insulated conducting wires or thin rod, *a*, *a*, by preference of copper, which carry two cups or hollow discs, *b* and b^1, of porcelain or other suitable insulating material, the cup, *b*, being near the bottom of the tube, and the cup, b^1, near its top. Each of these cups is placed in a metal ring, *k*, somewhat longer than the cup, so as to form a projecting rim of the same. The wires traverse the upper cup and pass into the lower one, which is fixed to their ends. For the purpose of preventing the wires from touching each other, and the tube, *e*, they are conducted through a cylinder, *d*, and a plug, d^1, made of wood or other insulatiug material. The outer end of the wires, *a*, *a*, is connected by means of other wires with an electric battery and an electro-magnet, which may be used for operating an alarm-bell or other signalling device, or an arrangement for extinguishing the fire or dropping the grate-bars, &c. Into the metal rings, *k*, forming the rim of the cups or discs, *b*, and b^1, are placed the rings, *c*, and respectively c^1, made of an easy fusible metal or alloy. The point of fusion of the lower ring, *c*, should be slightly higher than the temperature which the water in the boiler has at the maximum degreee of steam pressure allowed,



whereas the upper ring, c^1, must melt by the heat of the steam when at its lowest pressure. These rings are made to fit closely to the rim, *k*, in order to prevent their outer surface from being oxydised. On the inside they may be similarly protected by the end of the cylinder, *d*, and of the plug, d^1. The action of the apparatus is as follows:—While the water-level in the boiler is higher than the lower edge of the tube, *f*, water will be pressed by the steam into the annular space between the two tubes as far up as the air contained in this space permits. The part of the apparatus outside of the boiler being sufficiently long the surrounding air will keep the temperature of its top end considerably below the temperature of the steam when at its lowest degree of pressure. Under normal circumstances the upper ring, c^1, whose point of fusion may be, for instance, at 90° centigrade (194° F.) will, therefore, not melt. But when the water-level sinks below the lower edge of the tube, *f*,

steam will enter into the annular space between *e* and *f*, and by its heat melt the ring. The molten metal flows into the cavity, *h*, of the cup and produces contact between the two wires, *a*, *a*, whereby the electric apparatus is put into operation. When, on the other hand, the steam-pressure, and consequently the temperature of the water, become excessive, the lower ring, *c*, will melt and cause the electric contact between the wires, *a*, *a*, in a similar manner, as in the first case. The same effect is produced by an excess of temperature caused by retarded ebullition.

1961. "Magneto-electric machines." PAGET HIGGS. Dated May 5. 10d. The novelty of this invention consists chiefly in the ring armature whose construction is shown by the figure. This armature is formed of a number of spools; each of the latter consists of a core of iron slightly curved, so that it will conform to the curvature of the ring, and provided at its ends with circular discs, *e*, in which are slots or sockets, *a*, in which the ends of the arms are inserted, the spools being secured on the arms by steel set screws, *b*, *b*. The insulated wire in which the current is to be induced is coiled around these spools, and is connected down radiating arms to the shaft where the currents may be



collected in various ways. It will be seen that the spools so mounted constitute a continuous ring of soft iron covered by a series of coils separated by the ends, *e*, of the spools which project to the outer edge of the covered ring. This projection of the ends of the spools is an important feature, as it enables the iron of the armature to be brought near to the poles of the exciting magnets and prevents the armatures from heating. The solid rings heretofore used have been provided with corresponding projections between the sections of the coils for a similar purpose. It will be found advantageous to insulate the spools from each other and from the radiating arms, so that no currents can be induced in the ring itself. *c* shows a slip of mica or other insulating material between the ends of the spools for this purpose.

City Notes.

Old Broad Street, December 12th, 1881.

THE CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.—The Directors of this Company have declared an interim dividend of sixpence per share, free of income tax, payable on the 31st December, 1881. The directors believe they will be in a position to continue to pay regularly quarterly dividends of the same amount, which is equal to 10 per cent. per annum. Their circular to the shareholders states that considerable difficulty attended the first operations of the company owing to the necessary delay in obtaining premises and materials. Temporary premises in Kirby Street, Hatton Garden, were first engaged, but these having been found inadequate in size, large premises in Farringdon Road have been taken, and are being fitted up on an ample scale. It will be practicable, at the new factory, to manufacture besides telephones, electrical apparatus generally, including that for the electric light. The directors look forward to establishing a large manufacturing business. The company are about bringing out a new combination telephone, which it is expected will prove more serviceable and efficient than any instrument yet produced.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors announce an interim dividend of 3s. per share, or 6 per cent. per annum, for the quarter ended 30th September last.

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.—The offices of this Company are removed to Dashwood House, 9, New Broad Street, E.C., where communications should be addressed in future.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED, notify that they have opened a station at Maldonado, in Uruguay, for which place messages can be received at 15s. 8d. per word.

POST OFFICE CABLES.—The ss. *Morna*, of the Edinburgh and London Steam Shipping Company, has been chartered by the Post-office authorities (no regular cable ship being available) and fitted with the temporary cable gear which the General Post-office Submarine Department have ready at their depôt for such emergencies. She left her moorings on Friday evening, the 2nd of December, to commence repairs on several cables which have suffered during the late severe weather commencing from October. She goes first to Dartmouth (Guernsey) to lay a new shore end, the cable being broken close in shore. Then to Scilly for repairs, next Arran, renew cable at Rothsay Bay, another at Gareloch, new cable at Shian Ferry, Loch Creran, and then to lay two across the following lochs:—Etive, Loch Creran (independent) and Loch Leven. With over 60 cables to repair and maintain round the coast, it is high time that the Post-office officials should possess a vessel of their own for such purposes, as it is often a very difficult matter to charter a cable ship just when wanted.

DIRECT SPANISH CABLE.—For the repairs to this cable, the breaking down of which, in a heavy gale and in about 100 fathoms of water, we mentioned in our last issue, the India-rubber and Gutta-percha Company have engaged the Great Northern Company's ss. *Ærsted*. She has recently sailed for this purpose, Mr. H. Benest being the engineer in charge of the operations.

THE WLADIWOSTOCK-NAGASAKI CABLE.—The repair of this cable of the Great Northern Telegraph Company is announced.

OTHER TELEGRAPH CABLES INTERRUPTED.—It is announced that the Indo-European Telegraph Company's cables between Bushire and Jask are interrupted, and telegrams for India and countries beyond cannot therefore be accepted by that company's route, or by the Submarine Telegraph Company's route, *via* Turkey. The cable of the Paris and New York Company is interrupted, and telegrams cannot therefore, for the present, be transmitted by that company's route.